













Digitized by the Internet Archive  
in 2010 with funding from  
University of Toronto



28057

Institution of Mechanical Engineers.

---

GENERAL INDEX

TO

PROCEEDINGS.

---

1847-1873.

---

Q  
1874-84

PUBLISHED BY THE INSTITUTION,

81 NEWHALL STREET, BIRMINGHAM.

TJ  
/  
I 4  
Index  
1847-84

*Note.*—In the Index the Papers read at the meetings are entered under their subject heads, with details of their contents, and lists of the speakers in the discussions; papers on similar subjects are grouped together for reference.

Under the Members' &c. names are entered the titles of papers communicated by them, with references to their remarks in the discussions arranged under the subject heads; and the particulars are given of each Member's election &c. in the Institution.

Cross references are added to the subjects of the papers and to other subjects in the discussions &c.

The references are to the Year and Page in the Proceedings,—as 1861, 14; and the month is added in the references previous to 1853, the paging being separate for each Meeting.

# Institution of Mechanical Engineers.

## GENERAL INDEX

### TO PROCEEDINGS.

1847-1873.

#### A.

ABEL, C. D., elected Member, 1861, 14.

ACCOUNTS, abstract of receipts and expenditure, 1849, Jan., 5.—1850, Jan., 39.  
—1851, Jan., 40.—1852, 40.—1853, 44.—1854, 44.—1855, 34.—1856, 42.—  
1857, 10.—1858, 11.—1859, 12.—1860, 12.—1861, 12.—1862, 6.—1863, 12.—  
1864, 12.—1865, 12.—1866, 13.—1867, 13.—1868, 13.—1869, 15.—1870, 14.  
—1871, 14.—1872, 14.—1873, 15.

ADAMES, C. H., Compressed-Air Hammer, useful for planishing bright iron work, avoiding the moisture from steam, 1865, 99.

ADAMS, W., elected Member, 1859, 247.—Re-elected, 1866, 103.

ADAMS, W. A., elected Member, 1848, July, 19.

Brick Machinery, dry-clay machine-made bricks liable to fail at edges and corners, 1859, 46.—Dry-clay process successful for small china articles, 50.

Iron Manufacture, wheel tyres of tough wrought-iron apt to laminate, 1853, 30.

Iron Works, Round Oak, independent boilers more convenient than boilers heated by puddling furnaces, 1860, 220.

Railway Carrying Stock, *Paper* on railway carrying stock, 1850, Oct., 26.

Railway Carrying Stock, *Paper* on the improvement of the construction of railway carrying stock, 1851, Jan., 10.

Railway Wagons, *Paper* on improvements in the construction and materials of railway wagons, 1852, 206.

Springs, *Paper* on railway carriage and wagon springs, 1850, Jan., 19.—  
Conical spiral springs should be able to revolve during compression, 30.

ADAMS, W. A. (continued).

Springs, *Supplementary Paper* on railway carriage and wagon springs, 1850, Apl., 14.—Steady action of improved spring, 18.—Set of plates all given at centre, not bent to curve, 20.—Laminated springs cost not much more than india-rubber, 25.

Water Axlebox, cost of maintenance of ordinary brasses, 1860, 184.

Wrought-Iron Wheel, wheels working successfully with two wrought-iron discs riveted to cast-iron, 1849, Apl., 20.

ADAMS, W. B., Lubrication, *Paper* on railway axle lubrication, 1853, 57.

Spring, *Paper* on an improved spring and axlebox for railway carriages, 1855, 163.—Facility of inserting extra plates, 169.—India-rubber springs expensive, 170.—Steel has same elasticity in all forms of spring, 170.—Spring-beam tilt hammers cannot be worked long continuously, 171.

ADAMSON, D., elected Member, 1859, 13.

Bessemer Steel, admirably suited for making boiler plates, 1861, 149.—Plates require annealing, as they expand differently if rolled at different temperatures, 149.—Expansion of bars rolled at different temperatures, 153.

Blast-Furnaces, failure of central tube for taking off gas, 1864, 253.—Low pressure of blast preferred, 254.—Charge for furnaces working hæmatite, 259.

Boiler Construction, advisable to retain gusset and longitudinal stays, 1859, 228.—Firing below boiler objectionable when deposit formed from water, 228.

Boiler Explosions, plates not to have too high tensile strength, 1870, 206.—Desirable to diminish number of seams, 207.—Punching rivet-holes weakens plates more than drilling, 207.—Flanged seams to tubes of Cornish and other boilers, 208.—Measurement of boilers for permanent expansion after testing, 209.—Great floury deposit when grease in boiler, 209.

Coal Burning in Locomotives, evaporative duty low in locomotives; tubes should be shorter and firebox longer, 1860, 174.

Coalfield, Glasgow, steel wire ropes, difference in durability when passing under or over winding drum, 1864, 247.

Cornish Pumping Engine, higher pressure of steam desirable, 1862, 163.—Early cut-off not desirable, 163.—Cornish engine good for pumping, but not for driving machinery, 164.

Hydraulic Machines, loss of power in hydraulic riveter from full pressure throughout stroke, 1872, 205.—Steel-yard riveting machine for regulating pressure, 206.

Iron Manufacture, Hæmatite, importance of sufficient pressure of blast, 1871, 140.—Proper chemical proportions of slag, 141.

## ADAMSON, D. (continued).

Iron Works, vertical direct-acting blowing engine best, 1863, 231.—  
Waste gas might be used for calcining ironstone, 232.—Amount of  
materials passing through furnace per ton of iron made, 232.—Reduction  
in pressure of blast, 232.—Great length of boilers heated by waste gas,  
236.—Drilled holes should always be used for boilers, 236.—Cornish  
boiler better than plain cylindrical, 240.

Superheated Steam, steam should be superheated in passage between  
cylinders of compound engine, 1859, 207.

Tools, drilled holes far more reliable than punched, 1864, 214.—  
Importance of repeated testing of boilers, 215.—Boiler plates should be  
drilled together after bending to shape, 222.—Transmission of power by  
steam pipes to great distances, 224.

ADAMSON, J., elected Member, 1871, 262.

ADDENBROOKE, G., elected Member, 1853, 45.—Re-elected, 1861, 109.

Blast-Furnace Gas, *Paper* on an improved method of taking off the  
waste gas from open-topped blast furnaces, 1865, 235.—Fewer repairs to  
boilers and stoves when waste-gas used, 248.—Central suspended bell for  
taking off gas not a good plan, 249.—Durability and replacing of the  
castings, 250.—Liability to explosions when gas taken off under pressure,  
254.—Increased yield of furnace, 255.—Taking off gas with furnace top  
open, 1869, 35. — Particulars of mode of taking off gas from open-topped  
furnace, 75.

Boiler Lining, *Paper* on Whittle's plan for preventing deposit and  
incrustation in steam boilers, 1871, 48.—Success in removing scale, and  
economy of fuel, 56.

ADDISON, J., elected Member, 1851, July, 45.

ADDRESS of condolence to the Queen on the death of the Prince Consort,  
1862, 1.

ADDRESS of President, 1856, 125.—1861, 110.—1862, 94.—1869, 163.—1872, 120.

ADKINS, F., elected Member, 1853, 8.

AERO-STEAM ENGINE, *Paper* on the Warsop aero-steam engine, by R. Eaton,  
1870, 229.—Principle of engine, 229.—Mode of applying air-injection,  
229.—Early applications with greater proportion of air, 230.—Particulars  
of trials, 231.—Application to screw steamers, 233.—Effect on condensing  
engines, 233.—Prevention of priming and incrustation, 234.—Action of  
the air-injection, 236.

*Discussion.*—Bramwell, F. J., 240, 245. — Eaton, R., 237, 241, 243.—  
Fowler, G., 239.—Marten, E. B., 239, 244.—Siemens, C. W., 244, 245.—  
Tomlinson, J., 242.—Warsop, G., 241, 242, 244, 245.—Woods, H., 241,  
243, 244.

AERTS, M., Water Axlebox, distance run without replenishing water, 1860, 183.—End play for running round curves, 184.—Cost of repairs and brasses with ordinary axleboxes, 184.—Durability of brasses with water axleboxes, 185.—Provision against frost, 185.

AGRICULTURAL ENGINES, *Paper* on the application of steam power to agricultural purposes, by W. Waller, 1856, 80.—Portable engine most applicable to agricultural purposes, 81.—Early form of portable engine, 82.—Various forms of engines, 83.—Guide bars, 85.—Later forms of engines, 86.—Mode of testing, 90.—Table of weights to be applied to dynamometer, 92.—Duty performed, 92.—Indicator diagrams, 93.—Special peculiarities of engines, 93.—Arrangement of tubes, 95.—Fireboxes, 96.—Various applications of portable engines, 98.—Table of trials by Royal Agricultural Society, 100.—Table of dimensions of engines, 102.

*Discussion.*—Allen, E. E., 103, 104.—Chellingworth, T. T., 103.—Forsyth, T., 103.—Greaves, C., 106.—Lloyd, Sampson, 103, 106, 107.—Siemens, C. W., 105.—Waller, W., 103, 104, 106.

—IMPLEMENTS, STEAM, *Paper* on the application of steam power to agricultural purposes, by W. Waller, 1857, 41.—Ancient ploughs, 41.—Classification of steam-power implements, 43.—Locomotives dragging implements, 43.—Locomotives with rotary cultivators, 44.—Portable engines with ropes and windlasses, 46.—Portable engines with endless ropes, 47.—Locomotives working spades and diggers, 48.—Slide-valves of engines, 48.—Trials of consumption of coal, 50.—Apparatus for determining heating power of coal, 50.—Evaporative power of various fuels, 52.

*Discussion.*—Clift, J. E., 53.—Fothergill, B., 53.—Fowler, J., 53.—Hoskyns, C. W., 53.—Waller, W., 54.—Whitworth, J., 53, 54.

—MACHINERY, STEAM, *Paper* on the application of steam power to agricultural purposes, by W. Waller, 1856, 266.—Early threshing machines, 266.—Early winnowing machines, 270.—Mills, grinding, and flour dressing, 272.—Description of portable threshing machine, 273.—Details of drum, breastwork, &c., 274.—Straw shaker, 275.—Corn-dressing machine, 277.—Combined portable threshing machine, 278.—Action of threshing, 279.—Portable corn mill, 280.—Flour-dressing machine, 281.—Corn crushers, root cutters, &c., 281.—Working speeds of different parts of machines, 282.—Power expended in threshing, &c., 283.—Cost of threshing, 284.—Rate of threshing, 285.

*Discussion.*—Hawkes, W., 286.—Humphries, E., 286.—Lloyd, Sampson, 285, 286.

—STEAM CULTIVATION, *Paper* on steam cultivation, by J. Fowler, Jun., 1857, 57.—Early trials of draining plough, 57.—Description of draining plough, 58.—Anchor, 59.—Steam ploughing, 60.—Plough, 61.—Vertical windlass, 61.—Arrangement of tackle, &c., 62.—Speed of



## AGRICULTURAL, STEAM CULTIVATION (continued).

ploughing, 63.—Power required for ploughing, 64.—Expenses of working, 64.—Advantages of steam over horse ploughing, 65.—Durability and cost of wire rope, 66.

*Discussion.*—Atkins, T., 68.—Clift, J. E., 75.—Fowler, J., 71, 75.—Hawkes, W., 75.—Hoskyns, C. W., 69.—Siemens, C. W., 69.—Smith, W., 73.—Waller, W., 67.—Whitworth, J., 75, 76.

—STEAM CULTIVATION, *Paper* on the application of steam power to cultivation, by J. Fowler and D. Greig, 1865, 55.—Difficulties in applying steam power to cultivation, 55.—Traction engine impracticable, 56.—Stationary engine with rope passing all round field, 56.—Triangular arrangement of rope, 57.—Direct pull arrangement, 58.—Movable anchor, 58.—Endless rope arrangement, 59.—Clip drum, 61.—Compensating break for change of position of implement, 63.—Slack gear, 64.—Transportation of machinery, 66.—Ropes, 68.—Importance of ploughing in dry weather, 70.—Self-acting coiling gear, 71.—Ploughing implements, 72.—Comparison of steam with horse cultivation, 75.—Essential points in steam cultivating machinery, 78.

*Discussion.*—Bellhouse, E. T., 88.—Bramwell, F. J., 83, 87, 89, 90, 91.—Ferne, J., 80.—Greig, D., 79, 82, 84, 85, 87, 88, 89, 90, 91.—Hewett, E. E., 84, 90.—Richardson, W., 91.—Smith, J., 86.—Wright, T. B., 82.

AIR ENGINE, COMPRESSED, *Paper* on a compressed-air engine at Govan colliery, by C. Randolph, 1856, 145.—Arrangement of colliery, 145.—Shafts, 145.—Air-compressing engine, 146.—Ball valves for air-pumps, 146.—Compressed-air engine, 147.

*Discussion.*—Fairbairn, W., 150.—Fothergill, B., 149.—Harvey, R., 149.—Randolph, C., 148.—Rankine, W. J. M., 149.—Rogers, E., 149.—Whitworth, J., 149, 150.

AIR ENGINE, HEATED, *Paper* on Wenham's heated-air engine, by C. W. Cooke, 1873, 63.—History of heated-air engine, 63.—Stirling's engine, 63.—Regenerator, 64.—Ericsson's engine, 65.—Cayley's, 66.—Wenham's, 67.—Action of governor, 69.—Construction and lubrication of piston, 70.—Top of cylinder serves as air-pump, 70.—Work done by engine, 72.—Friction, 73.—Temperatures of air in engine, 73.—Consumption of coal, 74.

*Discussion.*—Amos, C. E., 81.—Cooke, C. W., 76.—Cowper, E. A., 79.—Gray, J. McF., 78.—Newton, W. E., 81.—Siemens, C. W., 82.—Welch, E. J. C., 77.—Wenham, F. H., 76, 78, 79, 80, 81.

AITKEN, W. C., Sand-Blast Process, gives good dead surface to metal plates, 1873, 275.—Frosted surface on glass, 276.

ALBARET, A., elected Member, 1858, 45.

ALEXANDER, A., elected Member, 1870, 125.

Ventilating Fan, spiral case best for fan, 1871, 71.—Fan and casing should be taper, with same area of passage throughout, 72.

ALLAN, A., Original Member, 1847.—Council, 1857, 11.—1859, 13.—1862, 19.—1864, 18.—1867, 17.

Axlebox, *Paper* on an oil axlebox for engines and tenders, 1853, 37.

Axlebox and Crossing, sponge axleboxes very durable, and small consumption of oil, 1852, 220.

Boiler, *Paper* on an improved steam boiler for locomotive and other engines, 1856, 233.

Feed-Pipe Connexion, *Paper* on a feed-pipe connexion for locomotive engines, 1862, 88.

Gas Meter, *Paper* on an improved gas meter, 1860, 15.

Link Motion, *Paper* on an improved construction of link motion for locomotive and other engines, 1856, 70.

Locomotive Boiler, tubes tried with rod through centre of each, 1849, July, 9.

Pressure Gauge, *Paper* on a new steam pressure gauge, 1859, 179.—Gauges for different pressures, 182.

Railway Springs, variable elastic force with change of load, 1858, 162.—Cost of tapering spring plates, 163.

Steam Railway Break, *Paper* on increased break power for stopping railway trains, 1859, 230.—Importance of break power being under control of engine driver, 235.

ALLEN, E. E., elected Member, 1856, 49.

Double-Cylinder Engines, importance of applying double-cylinder expansive engines for marine purposes, 1862, 276.—Economy obtained from high pressure and expansion, 277.—High pressure necessary for great economy, 287.—Limit to degree of expansion, 288.

Marine Engines, *Paper* on the commercial economy of working steam expansively in marine engines, with description of a new double expansive marine engine, 1855, 59.

Marine Engines, *Supplementary Paper* on the commercial economy of working steam expansively in marine engines, 1855, 97.—Impracticable to obtain full benefit of expanded steam in ordinary marine engines, 123.—Condenser advisable in all marine engines, 124.

ALLEN ENGINE, *Paper* on the Allen engine and governor, by C. T. Porter, 1868, 50.—Objects to be aimed at in carrying out expansion, 50.—General description of Allen engine, 51.—Valves and valve-motion, 51.—Single eccentric, 53.—Expansion link, 55.—Speed of piston, 57.—Condenser and air pump, 61.—Governor, 63.—Special construction, 64.—Attachment of cylinder, 65.—Large and accurate bearings, 65.

## ALLEN ENGINE (continued).

*Discussion.*—Coventry, A., 76.—Cowper, E. A., 66, 67, 73.—Ferne, J., 75.—Hawksley, T., 72, 80.—Olrick, L., 74.—Porter, C. T., 66, 73, 76.—Reynolds, E., 68, 73.—Siemens, C. W., 67.—Webb, F. W., 68.—Woods, H., 75.

ALLEN GOVERNOR. *See* Governor, 1873, 47.

ALLEN, J., elected Member, 1856, 79.—Decease, 1865, 2.—Memoir, 13.

ALLEN, W. D., elected Member, 1865, 53.

ALLEY, J., elected Member, 1870, 125.

ALLEYNE, Sir J. G. N., elected Member, 1865, 20.

ALLFREY, E. R., Marine Engines, importance of steam jackets, 1872, 175.—Single-cylinder engine as good result as compound, 178.

ALLHUSEN, H. C., Furnace, Revolving Chemical, *Paper* on a revolving furnace for chemical works, 1869, 229.—Durability of lining, 236.

ALLIBON, G., elected Member, 1867, 18.

ALLIN, S. S., Corn-Mill, Buchholz, larger produce and better bread from flour free from cerealine, 1872, 236.—Loss of nutriment very slight by removing cerealine, 237.—Chemical properties of cerealine, 237.

ALLIOTT, J. B., elected Member, 1872, 119.

ALLPORT, H. A., elected Member, 1871, 21.

ALSTON, W. C., elected Honorary Member, 1848, Apl., 24.

ALTON, G., elected Member, 1859, 97.

AMALGAMATING AND CRUSHING MACHINE. *See* Crushing, 1854, 33.

AMERICAN DOVETAILING MACHINE. *See* Dovetailing Machine, 1868, 81.

AMERICAN LOCKS. *See* Locks, 1851, June, 16.

AMOS, C. E., elected Member, 1861, 211.—Council, 1868, 19.—1870, 18.—1872, 25.

Air Engine, Heated, Ericsson engine small power and high consumption, 1873, 81.—Great absorption of power in heated-air engine, 81.—Safety from explosion or fire, 82.

Railway Chair, Bracket, wrought-iron rail but little injured by bolt hole, 1873, 256.—Steel rail very variable in strength, 257.

Sand-Blast Process, very successful for carving stone, 1873, 274.—Lace template for ornamenting glass, 275.

AMOS, J. C., elected Member, 1867, 59.

ANDERSON, J., elected Member, 1856, 250.—Council, 1861, 13.—1864, 18.—1867, 17.—Vice-President, 1868, 19.—1869, 19.—Council, 1870, 18.—1873, 24.

Blast Furnaces, attention should be paid to quality rather than to quantity of yield, 1864, 182.—Effect of chemical composition on tensile strength of iron, 185.

ANDERSON, J. (continued).

Copying Machinery, *Paper* on some applications of the copying or transfer principle in the production of wooden articles, 1858, 237.

Rifled Gun Manufacture, *Paper* on the application of the copying principle in the manufacture and rifling of guns, 1862, 125.—Construction of vernier measuring instrument, 141.

ANDERSON, W., elected Member, 1856, 79.

ANDREWS, J., Rock Boring Machine, tools sharpened less frequently than in hand boring, 1865, 195.—Rate of advance of Roundwood tunnel, 196.—Mont Ceuil tunnel boring machine, 197.

ANEMOMETER, by A. F. Osler, 1852, 91.

ANGUS, R., elected Member, 1862, 93.

ANNUAL REPORT OF COUNCIL. *See* Council.

APPLEBY, C. E., elected Member, 1858, 79.

APPLEBY, C. J., elected Member, 1867, 59.

APPLEBY, H., elected Member, 1873, 45.

APPOLD, J. G., Centrifugal Pump, description of Appold pump, 1852, 155.—Particulars of experiments on ditto, 156.—Effect of size of pump and velocity on discharge, 158.—Advantages of centrifugal pump, 160.—Dimensions and cost of largest Appold pump, 160.—Table of experiments on do., 161.—Centrifugal pump most advantageous for low variable lifts, 162.—Importance of curved arms, 162.—Duty of pumps with differently shaped arms, 163.

APPOLT COKE OVEN. *See* Blast-Furnace Materials, 1871, 151.

ARMITAGE, H. W., elected Member, 1861, 14.

ARMITAGE, W. J., elected Member, 1859, 53.

ARMOUR, IRON, for Ships, *Paper* on the construction and application of iron armour for ships of war, by N. S. Russell, 1862, 289.—Wooden ships coated with armour very inefficient, 289.—Armoured vessels must be large, 290.—Three modes of construction of armoured vessels, 291.—Examples of armoured ships, 292.—Stevens battery, 293.—Several thin armour plates not equal to one thick plate, 295.—Modes of construction with iron backing, 296.—Continuous riveting to attach armour plates, 296.—Area of fastening by bolts generally inadequate, 298.—Power of shot at high velocities, 299.—Dimensions of vessels required to carry different thicknesses of armour, 300.

*Discussion.*—Armstrong, Sir W. G., 311.—Cowper, E. A., 305.—Plum, T. W., 305.—Pole, W., 301, 306.—Ramsbottom, J., 306.—Reed, E. J., 309.—Russell, J. S., 307.—Russell, N. S., 305, 309.—Shelley, C. P. B., 305.

ARMOUR PLATES. *See* Steel Rails and Armour Plates, 1861, 121.

ARMSTRONG, G., elected Member, 1866, 103.

ARMSTRONG, JOHN, elected Member, 1863, 113.

ARMSTRONG, JOSEPH, elected Member, 1857, 11.

ARMSTRONG, T., elected Graduate, 1872, 120.

ARMSTRONG, Sir W. G., elected Member, 1858, 12.—Vice-President, 1859, 13.—1860, 13.—President, 1861, 13.—1862, 19.—1869, 19.

Address as President, 1861, 110.—Progress of mechanical engineering, 110.—Steam navigation, railways, 111.—Steam cultivation of land, 112.—Improvements in tools, 113.—Rifled guns and armour plates, 114.—Cast iron unfit for rifled guns, 115.—Construction of guns on the coil system, 117.—Patent laws, 118.

Address, 1862, 94.—International exhibitions, 94.—Prince Consort, 94.—Guns, 96.—Armour plates, 97.—Krupp steel, 97.

Address, 1869, 183.—Watt's first steam engine, 183.—Advance of mechanical engineering during last eleven years, 185.—Atlantic telegraph, 186.—Suez canal, 186.—Coal mining, duration of English coalfields, 187.—Mechanical appliances for coal mining, 188.—Guns, rifled, breech-loading, 189.—High temperature of explosion, 190.—Construction of heavy ordnance, 192.—Wrought iron better than steel for guns and armour plates, 193.—Powder, slow and quick burning, 194.—Armour-plated ships, 196.—Shot, chilled cast-iron better than steel, 197.—Unarmoured gunboats, 198.—Moucrieff gun carriage, 199.

Armour Plates, difficulty in properly welding heavy plates, 1861, 130.—Cast steel not suitable for armour plates, 131.—Heavy hammer important in forging plates, 131.

Bessemer Steel, heavy hammers essential for very large forgings, 1861, 154.—Steel not succeeded hitherto for guns, 155.

Bridge, Hydraulic Swing, *Paper* on the hydraulic swing bridge for the North Eastern Railway over the river Ouse near Goole, 1869, 121.—Steam power required to work bridge, 129.—Mode of preventing the water freezing in winter, 131.

Hydraulic Machinery, *Paper* on the transmission of power by water pressure, with the application to railway goods stations, forge and foundry cranes, and blast-furnace hoists, 1868, 21.

Pump Valves, durability of india-rubber valves with free lift, 1858, 255.

Steam Boilers, Mechanical Firing, adoption of Vicars' furnace at Elswick Works, 1869, 180.

Water-Pressure Machinery, *Paper* on water-pressure machinery, 1858, 126.—Importance of relief valves in preventing over pressure, 133.—Water-pressure convenient for conveying power to a distance, 142.—Joints of hydraulic machinery, 143.—Provision against freezing of water, 144.

ARMSTRONG, W. I., elected Member, 1870, 125.

ARNOLD, D. N., elected Member, 1873, 45.

ARTESIAN WELLS, machinery for boring. *See* Well Boring. 1867, 174.



ASHBURY, J., elected Member, 1848, Apl., 23.—Decease. 1867, 2.—Memoir, 14.

ASHBURY, J. L., elected Member, 1857, 201.

Steel Tyres, comparative cost of iron and crucible steel tyres, 1866, 192.

ASHBURY, T., elected Member, 1873, 45.

ASHTON AND STOREY'S Steam Power Meter and Continuous Indicator. *See* Indicator. Continuous, 1871, 75.

ATKINS, T., Steam Cultivation, rotary cultivator preferable to plough, 1857, 68.

ATKINSON, C., elected Member, 1858, 12.

Regenerative Furnace, saving of fuel in steel-melting furnace, 1857, 106.—  
Saving in brickwork repairs, 107.

ATKINSON, C. F., elected Member, 1870, 125.

ATLANTIC TELEGRAPH CABLE, machinery for laying and picking up. *See* Telegraph Machinery, 1867, 20.

ATLAS LOCOMOTIVE ENGINE. *See* Locomotive, 1847, Nov., 3.

AUSTER, T., elected Member, 1848, Apl., 23.

AUSTIN, W. L., elected Member, 1869, 276.

AVELING, T., elected Member, 1869, 119.

Steam Road Roller, *Paper* on a steam road roller, 1870, 109.—Stones of road rapidly destroyed if not rolled, 170.—Conical rollers best, 171.—Bearing springs not of much use, 172.—One cylinder for engine better than two, 173.—Single axle for both the side rollers, 173.—15-ton roller better than 30-ton, 176.—Roller should consist of several rings of small width, 1869, 116.—Particulars of working, 117.

AXLES, *Paper* on railway axles, by J. E. McConnell, 1849, Oct., 13.—Importance of proportion and quality in the materials of railway moving stock, 14.—Great diversity of practice in proportioning strength of axles, 15.—Strength required to resist stationary load, 15.—Strains from inequalities of road and side play between rails, 17.—Torsion caused by travelling over curves and strain of break blocks, 18.—Constant vibration altering axle from fibrous to crystalline state, and gradual failure at back of wheel, 18.—Experiments to determine correct proportions for axles, 19.—Diameter reduced in centre portion, 20.—Locomotive crank axles subjected to more rapid deterioration, 21.—Change in iron from fibrous to crystalline well established, 21.

*Discussion*.—Cowper, E. A., 24.—Henderson, J., 22.—Ramsbottom, J., 24.—Slate, A., 26.—Smith, H., 24, 26.—Stephenson, R., 21, 22, 25, 26.

AXLES, *Supplementary Paper* on the deterioration of railway axles, by J. E. McConnell, 1850, Jan., 5.—Example of crystalline fracture of axle with cast-iron wheels, 6.—Experiments on effects of concussion on axles with elastic and with cast-iron wheels, 7.—Experiments on effect of cold-hammering on fibrous iron, 8.—Effect of water on axle heated by running dry, 9.—Bending of axle by side blow on wheel flange, 10.—

## AXLES (continued).

Crystallising effect of rapidly repeated pulls on tough iron, 10.—Effect of rapidly repeated end blows on tough wrought-iron bar, 11.—Fracture of wrought-iron helve, 11.—Crystalline fracture of wrought-iron pin, caused by frequent jar, 12.—Conclusions as to proportions &c. of railway axles, 13.

*Discussion.*—Cowper, E. A., 14, 16, 17.—Heaton, G., 18.—Hoby, J. W., 17.—Hodge, P. R., 15, 16, 17, 18.—Jackson, P. R., 15, 18.—McConnell, J. E., 14, 15, 18, 19.—Middleton, W., 18.—Slate, A., 16.—Smith, H., 15.—Smith, W., 18.—Williams, W., 14, 16.—Wright, H., 14.

AXLES, *Supplementary Paper* on the deterioration of railway axles, by J. E. McConnell, 1850, Apl., 3.—Proper form of axle, 3.—Crystalline structure produced by concussion or jarring, 4.—Shoulder on axle at wheel boss aggravates tendency to break, 5.

*Discussion.*—Adams, W. A., 8.—Cowper, E. A., 12.—McConnell, J. E., 8.—Robinson, H., 12, 13.—Slate, A., 11, 12.—Smith, H., 8.—Stephenson, R., 6, 9, 11, 12, 13.—Walker, T., 11.

AXLES, *Paper* on the form of shafts and axles, by T. Thornycroft, 1850, July, 35.—Investigation of best forms for parts of machinery, 36.—Alteration in form of shafts from former practice, 38.—Relation of railway axle to girder, 39.—Experiments on deflection of axles, 39.—Effect of reducing diameter of axle in middle, 40.—Influence of shoulder on axle just behind wheel, 40.—Influence of position of wheel in relation to neck of journal, 41.—Deductions from experiments, 41.

*Discussion.*—McConnell, J. E., 42.—Thornycroft, T., 41, 42.

AXLES, *Supplementary Paper* on the form of railway axles, by T. Thornycroft, 1850, Oct., 4.—Axles reduced in diameter at middle unable to keep their form under heavy shocks, 5.—Nicking iron to only slight depth greatly reduces strength, 5.—Repeated bending without concussion produces crystalline structure, 6.

*Discussion.*—Allan, A., 9.—Bowman, R., 7, 8, 10.—Cowper, E. A., 9, 11.—Henson, H. H., 9.—McConnell, J. E., 9, 11, 12, 13, 15.—Middleton, W., 11.—Owen, W., 9.—Peacock, R., 8, 9, 12.—Ramsbottom, J., 9, 13.—Shipton, J. A., 10.—Slate, A., 7, 8, 10.—Smith, H., 12.—Thornycroft, G. B., 12, 13, 15.—Thornycroft, T., 6, 8, 9.—Williams, R., 11.—Wright, H., 9.

AXLES, *Paper* on hollow railway axles, by J. E. McConnell, 1853, 87.—Strength of tubes, 88.—Description of mode of manufacture, 89.—Formation of journals, 90.—Saving in weight of axles, 91.—Double conical journals, 91.—Experiments on relative strength of solid and hollow axles, 91.—Tables of experiments, 94.

*Discussion.*—Adams, W. A., 100.—Blackwell, S. H., 96, 97, 99, 100.—Clift, J. E., 97.—Duclos de Boussois, E., 98.—England, G., 99.—Mathews,

## AXLES (continued).

W., 96, 97.—May, C., 98, 99.—McConnell, J. E., 96, 97, 98, 99, 100.—Nasmyth, J., 98, 99.—Norris, R. S., 97.—Slate, A., 97, 98, 99.

AXLES, alteration from fibrous to crystalline state in working, 1849, Oct., 18, 22, 24, 26.—1850, Jan., 6, 10, 16, 18.—Apl., 4, 7, 8.—July, 41.—Oct., 6, 15.—Break frequently near ends, but very seldom in the middle, 1850, Oct. 9.

AXLES OF LOCOMOTIVES, distribution of weight on. *See* Locomotives, distribution of weight, 1864, 92.

AXLEBOX, *Paper* on an improved axlebox for railway engines and carriages, by J. Barrans, 1851, Jan., 30.—Wear of axle bearings, 30.—Description of improved axlebox, 31.—Modifications, 32.—Grit shield, 33.—Oil lubrication, 33.

*Discussion.*—Adams, W. A., 34.—Barrans, J., 34.—Henson, H. H., 34.—Wright, H., 34.

AXLEBOX, *Supplementary Paper* on an improved axlebox for railway engines and carriages, by J. Barrans, 1851, Apl., 3.—Axlebox with oil lubrication, 3.—Particulars of working, 4.

*Discussion.*—Adams, W. A., 6, 8.—Barrans, J., 5, 6.—Cowper, E. A., 5, 7.—Henson, H. H., 6, 7.—McConnell, J. E., 5, 6, 7.—Sandom, 7.—Slate, A., 5, 6.

AXLEBOX, *Paper* on an oil axlebox for engines and tenders, by A. Allan, 1853, 37.—Axlebox for driving wheels of engines, 37.—Axlebox for tenders, 38.—Working expenses, 38.

*Discussion.*—Allan, A., 39.—Fothergill, B., 39.—Lea, J., 39.—McConnell, J. E., 39.—Stephenson, R., 39.

AXLEBOX, *Paper* on an improved axlebox and spring fittings for railway carriages, by W. G. Craig, 1855, 182.—Defects of ordinary axleboxes, 183.—Defects of spring fittings, 184.—Description of improved axlebox, 185.—Grease covers, 186.—Spring fixing, 187.—Spring fittings, 187.—Proportion of defective axleboxes, &c., 188.

*Discussion.*—Beyer, C. F., 190.—Jackson, P. R., 190.—Newall, J., 189, 190.—Ramsbottom, J., 189, 190, 191.—Sinclair, A., 190.

AXLEBOX AND COUPLING ROD, *Paper* on an improved construction of axleboxes and coupling rods for locomotive engines, by W. A. Fairbairn, 1858, 166.—Description of improved axlebox, 166.—India-rubber washers, 167.—Axlebox for driving wheels of engine, 167.—Coupling rod, 168.

*Discussion.*—Cowper, E. A., 169.—Fairbairn, W., 169, 170.—Smith, W., 169.—Whitworth, J., 170.

AXLEBOX AND CROSSING, *Paper* on a new self-lubricating axlebox for railway engines and carriages, and a self-acting spring crossing point, by P. R. Hodge, 1852, 213.—Oil superior to tallow for lubrication, 213.—



## AXLEBOX AND CROSSING (continued.)

Description of improved axlebox, 214.—Saving in cost of lubrication and in weight, 215.—Advantages, 215.—Self-acting point for crossings, 216.

*Discussion.*—Adams, W. A., 219.—Allan, A., 220, 221, 222.—Chellingworth, T. T., 220.—Forsyth, T., 222.—Jones, E., 218, 220.—Lea, J., 217.—McConnell, J. E., 217, 219, 220, 221.—Slate, A., 221.—Stephenson, R., 218, 219, 221, 222.—Wright, H., 219, 220.

AXLEBOX AND SPRING for railway carriages. *See* Spring, 1855, 163.

AXLEBOX, WATER. *Paper* on Aerts' water axlebox. by Sampson Lloyd, 1860, 178.—Essential conditions for good lubrication, 178.—Description of water axlebox, 178.—Joint to prevent leakage of water, 179.—Cleaning the axlebox, 180.—Axlebox applied to shafting, 180.—Results of use of water axlebox on railways, 181.

*Discussion.*—Adams, W. A., 184.—Aerts, M., 182, 184, 186.—Cowper, E. A., 186.—Kennedy, J., 187.—Lloyd, Sampson, 182, 185, 187.—Siemens, C. W., 186, 187.—Wright, J., 187.

AXLEBOX LUBRICATION. *See* Lubrication, 1853, 57.

## B.

BAGNALL, W., elected Member, 1848, Apl., 23.—Decease, 1864, 2.—Memoir, 13.

BAGSHAW, W., elected Graduate, 1872, 26.

BAGSHAW, J. J., elected Member, 1865, 101.

BAILEY, J., elected Member, 1865, 53.

BAILEY, S., elected Member, 1860, 89.

Coal Cutting Machine, speed of working, 1864, 238.

BAILLY, P., elected Member, 1872, 119.

BAINBRIDGE, E., elected Graduate, 1869, 277.

BAINES, W., elected Member, 1866, 55.

Railway Chairs and Switches, *Paper* on improved railway chairs and switches, 1849, Jan., 21.—Comparative cost of chairs, keys, and spikes, Apl., 5.—Joint chair supports rail ends firmly without ballast, 6.—Wider chair used for replacing any broken chair, 7.—Deep switch tongue for driving dirt under main rail instead of against it, 7.

Railway Signals, *Paper* on improved apparatus for working and interlocking railway signals and points, 1873, 31.—Signal wires, breakage in frosty weather, 41.—Great variation in length of signal wires in Russia, 41.—Facility for repairs in improved apparatus, 42.—Automatic locking of points when train passing, 43.

Turntable, Wrought-iron, *Paper* on an improved construction of wrought-iron turntable, 1866, 43.—Load that turntables will carry, 50.—Cost about the same as cast-iron turntables, 52.

BAIRD, G., elected Member, 1873, 87.

BAKER, S., elected Member, 1866, 264.

BAKER, W., elected Member, 1848, Apl., 23.

BAKER, W. P., Corn Mill, Buchholz, *Paper* on the Buchholz process of decorticating grain, and making semolina and flour by means of fluted metal rollers, 1872, 225.

BALANCED SLIDE-VALVE, *Paper* on a balanced slide-valve for locomotive engines, by W. G. Beattie, 1871, 35.—Great pressure on back of ordinary valve, 35.—Opposing pressure from steam in cylinder, 35.—Actual power required to move slide-valve under steam, 36.—Description of balanced slide-valve, 37.—Mode of packing, 37.—Experiments on power required to move balanced valves under steam, 38.—Facility of reversing under steam, 39.—Valves and spindles lighter and much cheaper than ordinary ones, 39.—Wear very slight, 39.—Great saving in power required to work valves, 40.

*Discussion*.—Beattie, W. G., 41, 43, 45.—Bramwell, F. J., 43, 45.—Cowper, E. A., 45.—Kirtley, W., 45.—Ramsbottom, J., 43, 46, 47.—Robinson, J., 45, 47.

BALANCED VALVE, *Paper* on balancing the valves of steam engines, by C. F. Beyer, 1857, 189.—Ordinary D valve, 189.—Great power required to start it, 189.—Parallel equilibrium valve, 19.—Circular balance valve, 190.—Steam-hammer valve, 191.—Locomotive slide-valve, 191.—Duplex valve, with expansion cut-off, 191.—Ordinary locomotive valve, wear from unbalanced pressure, 192.

*Discussion*.—Maudslay, H., 193.—McConnell, J. E., 195.—Morrison, R., 193.—Pilkington, R., 193, 195.—Tomlinson, J., 194.—Wilson, J., 192, 194.

BALANCED VALVE for steam hammer, preferable to self-acting gear, 1857, 192, 193.

BALANCING OF WHEELS, *Paper* on the balancing of wheels, by J. E. McConnell, 1848, June, 2.—Advantages of balancing railway wheels and other machinery, 2.—Violent shaking of lathe and fan at high speed removed by balancing, 3.—Centrifugal forces of unequal revolving bodies, 4.—Means of balancing engine wheels with crank axle, 5.—Wear of flat place in wheel tyre caused by want of balance, 5.—Model illustrating effects of want of balance in wheels, 6.

*Discussion*.—Cowper, E. A., 8.—McConnell, J. E., 6, 7.—Middleton, W., 7.

BALDWIN, J., Steam Road Roller, weight of roller per inch width of rollers not equal to heavy vans, 1870, 119.—Small gravel better than sand for binding road-metalling, 119.

BALDWIN, M., elected Member, 1865, 20.—Decease, 1873, 2.—Memoir, 16.

BANK-NOTE PRINTING Machine. *See* Printing Machine for Bank Notes, 1865, 166.

BARBER, J., Decimal Measurement, use of metre gauge in making Giffard injector, 1860. 231.

BARBER, T., Jun., elected Member, 1870, 19.

BARCLAY, A., elected Member, 1870, 19.

BARCLAY, J., elected Member, 1860. 13.

BARCLAY, W., elected Member, 1865. 53.

BARKER, F., elected Honorary Member, 1865, 219.

BARKER, G., elected Member, 1866. 264.

BARKER, P., elected Member, 1860, 89.

BARLOW, E., elected Member, 1863, 57.

BARN MACHINERY. *See* Agricultural.

BARNARD, C., elected Member, 1866. 55.

BAROMETER, Bourdon's Metallic. *See* Pressure Gauge, 1852, 141.

BARRANS, J., Axlebox, *Paper* on an improved axlebox for railway engines and carriages, 1851, Jan., 30.

Axlebox, *Supplementary Paper* on an improved axlebox for railway engines and carriages, 1851, Apl., 3.—Engines run more steadily with improved axlebox, 5.

BARROW, J., elected Member, 1862, 314.

BARROWS, T. W., elected Member, 1867, 59.

BARRY, J. W., elected Member, 1871. 65.

BARRY, W. H., elected Associate, 1873. 250.

BARTON, E., elected Member, 1862, 314.

Iron Manufacture, Hæmatite, advantage of parallel throat to blast furnace, 1871, 139.

BARWELL, W. H., elected Member, 1847.—Decease, 1865. 2.—Memoir. 13.

BASHFORTH, F., Teeth of Wheels, *Paper* on the formation of the teeth of the drivers of pin-wheels, 1848, Apl., 4.

BASS, W., elected Member, 1865. 20.

BASTOW, S., elected Member, 1859. 53.

Boiler Construction, plain cylindrical boiler most durable, 1859. 224.

Boiler Economy, great length of plain cylindrical boilers in iron districts of the North, 1859. 167.

BATEMAN, J. F., Water Works, Manchester, *Paper* on the Manchester Water Works, 1866, 245.

BATHO, W. F., elected Member, 1860. 250.

Drilling Machine, durability of drills, 1856, 112.—Expanding drill, 112.

Nut-Shaping Machine, *Paper* on an improved machine for shaping nuts, &c., 1869, 312.

Steam Road Roller, *Paper* on a steam road roller, 1870, 109.—Importance of rolling roads to preserve sharp edges of stones, 118.—Bearing springs enable to roll quicker, 122.—Picking by hand necessary after use of spiked roller, 123.

BATLEY, W., elected Member, 1851, July, 45.

BAYLISS, T. R., elected Member, 1872, 26.

BEACOCK, R., elected Member, 1859, 247.

BEALE, M., elected Associate, 1868, 104.

BEALE, W. P., elected Member, 1860, 250.

Coal Mining, successful employment of wrought-iron props, 1862, 85.

BEAUMONT, F., Major, elected Member, 1867, 59.

BEARD, G., Puddling Machine, connection of rabble to machinery must not be too rigid, 1864, 307.—Better iron produced by machine puddling, 307.

BEARDSHAW, C. C., elected Member, 1865, 218.

BEARINGS, WOOD. *See* Wood Bearings, 1856, 24.—1858, 81.

BEASLEY, J., elected Member, 1851, Apl., 45.

Blooming Machine, *Paper* on a new machine for blooming iron, 1851, Apl., 36.

Blooming Machine, *Supplementary Paper* on a new machine for blooming iron, 1851, June, 3.—Strength of iron from machine, 11.—Saving in wages, 12.—Cinder thoroughly squeezed out, 12.—Hammered iron liable to contain cinder, 13.—Iron hot enough to weld on leaving machine, 14.

BEATTIE, J., elected Member, 1848.—Decease, 1872, 2.—Memoir, 15.

Locomotive Engine, *Paper* on an improved locomotive engine, 1854, 24.—Combustion chamber in middle of boiler, 32.

BEATTIE, W. G., elected Member, 1869, 77.

Slide-Valve, Balanced, *Paper* on a balanced slide-valve for locomotive engines, 1871, 35.—Balanced valves keep in working order longer than ordinary valves, 41.—Re-facing and re-packing wanted after 18 months, 41.—Different constructions of packing, 42.—No appreciable wear of valve motion in  $2\frac{1}{2}$  years, 43.

BECK, E., elected Member, 1859, 13.

BECK, R., elected Member, 1860, 53.

BECK, W. H., elected Member, 1873, 45.

BECKETT, H., elected Member, 1862, 93.

BECKTON, J. G., elected Member, 1864, 121.

Blast Furnaces, *Paper* on the construction of blast furnaces and the manufacture of pig iron in the Cleveland district, 1864, 249.

BELL, C., elected Member, 1865, 101.

BELL, G., elected Member, 1867, 18.—Decease, 1871, 2.—Memoir, 15.

BELL, I. L., elected Member, 1858, 266.—Council, 1870, 18.—Vice-President, 1872, 25.—1873, 24.

Blast Furnaces, experiments on large furnace, 1869, 49.—Difficulty of calculating ultimate economic capacity, 51.—Want of better pyrometer, 53.—Larger furnaces give relatively less saving, 54.—Experiments on action of carbonic oxide on ironstone, 55.—Mode of estimating saving

BELL, I. L. (continued).

due to lower temperature of escaping gas, 56.—Rate of saving diminishes rapidly with increased capacity, 58.—Theoretical minimum consumption, 59.

Blast-Furnace Materials, *Paper* on the preliminary treatment of the materials used in the manufacture of pig-iron in the Cleveland district, 1871, 147.—No advantage from reduction of ore before charging, 169.—Small furnaces probably best, 172.—Impossible to distinguish between grey and white iron by analysis, 172.—Desirable to calcine ore before charging, 172.

Furnace, Revolving Chemical, not much gain except in saving of labour, 1869, 234.—Lining of revolving furnace, 237.

Hot-Blast Stoves, regenerative stoves give much higher temperature than ordinary cast-iron stoves, 1870, 80.—Arrangement for utilising heat escaping from cast-iron stoves, 81.—Doubtful if greater control over furnace from increased heat of blast, 81.—Further increase in capacity of furnace causes not much reduction in temperature of escaping gases, 83.—Impossible greatly to increase proportion of carbonic acid in escaping gases, 84.—No economy possible from separate reduction of ore before charging, 87.

Iron Manufacture, *Hæmatite*, charcoal not superior to coke for fuel, 1871, 143.—High blast-furnaces probably not best for hæmatite district, 144.

Steam Boilers, Mechanical Firing, greater percentage of ash in small than in large coal, 1869, 179.

BELL, J., elected Member, 1865, 218.

BELL, PNEUMATIC. *See* Pneumatic Signal Bell, 1857, 83.

BELL, T., Water Meter, accuracy of Siemens' meters under varying pressures, 1856, 121.—Piston meters not successful, 122.

BELLHOUSE, E. T., elected Member, 1857, 201.

Railway Bridges, important to allow margin in weight of metal beyond that required for safety, 1861, 186.—Protection from corrosion very important, 186.

BELLISS, G. E., elected Member, 1868, 103.

BENNETT, H., elected Member, 1865, 20.

Puddling Machine, *Paper* on puddling iron by machinery, 1864, 298.

BENNETT, P. D., elected Member, 1854, 110.

Blast Furnaces, Scotch irons stand higher tests than Staffordshire, 1864, 185.

BENNETT, W., Jun., elected Member, 1872, 119.

BENSON, G. H., elected Member, 1865, 20.

BENSON, M., elected Member, 1865, 20.

Boiler, High-Pressure, importance of maintaining circulation in tubular boilers, 1859, 274.—Freedom from deposit, 274.—Tube joints, 275.—



BENSON, M. (continued).

Replacing defective tube, 275.—Rapid raising of steam in fire engines, 276.—Evaporative duty, 276.—Wrought-iron tubes soon destroyed by fire if circulation of water deficient, 1861, 41.—Facility for repairs, 41.

BENTLEY, J. G., elected Member, 1873, 45.

BERDAN Crushing and Amalgamating Machine. *See* Crushing, 1854, 33.

BERKLEY, G., elected Member, 1847.—Re-elected, 1867, 234.

BERNHARDT, G., elected Member, 1867, 59.

BESSEMER, H., elected Member, 1861, 109.—Council, 1871, 20.

Bessemer Steel, *Paper* on the manufacture of cast steel and its application to constructive purposes, 1861, 133.—Bessemer process more economical than cementation, 146.—Great saving of time, 147.—Facility for making steel of any degree of hardness, 148.—Great facility for judging of quality of metal during process, 152.—Steel boiler plates less liable to corrosion than iron, 152.—Strength of steel guns, 155.—Process of casting and forging a gun, 156.—Not much hammering requisite to give metal its maximum tensile strength, 157.

Railway Bridges, mode of sinking tubular piles in sand by means of a stream of water, 1861, 185.

BESSEMER STEEL. *See* Steel, Bessemer, 1861, 133.

BETHELL, J., Creosoting Timber, amount of creosote absorbed by wood, 1851, Oct., 15, 16.—Protection against the teredo, 15.

BEVIS, R. R., elected Member, 1866, 55.

BEWLAY, H., elected Member, 1870, 61.

BEYER, C. F., Original Member, 1847.—Vice-President, 1847.—1848.—1849, Jan., 9.—1850, Jan., 4.—1851, Jan., 8.—1852, 8.—1853, 7.—Council, 1854, 5.—1856, 6.—1858, 12.—1861, 13.—Vice-President, 1863, 14.—1864, 18.—1865, 19.—1866, 16.—1867, 17.

Atlas Engine, *Paper* on the luggage engine "Atlas," 1847, Nov., 3.

Balanced Valve, *Paper* on balancing the valves of steam engines, 1857, 189.

Boring Locomotive Cylinders, *Paper* on boring and fitting up cylinders for locomotive engines, 1848, Apl., 3.

Compressed-Air Hammer, *Paper* on Waterhouse's compressed-air forge hammer, 1858, 118.

Locomotive Boiler, degree of exhaustion in smokebox, 1849, July, 10.

Tuyere, *Paper* on an improved tuyere and smith's hearth, 1855, 125.

Valve Packing, *Paper* on Waddell's improved packing for the slide-valves of marine engines, 1856, 61.

Wrought-Iron Wheel, cast-iron locomotive wheels working well many years, 1849, Apl., 19.

BINNS, C., elected Member, 1861, 53.

BIRCKEL, J. J., elected Member, 1863, 246.

Pump, Horizontal V, *Paper* on a horizontal V pump, 1864, 33.—Greater delivery than ordinary pump, 38.—Working parts easily accessible, 39.—Better vacuum than ordinary pump, 40.

BIRD, A., Filter, sandstone filter rapidly choked, 1854, 77.

Signal, transmission through column of water containing large amount of air, 1854, 54.

BIRKBECK, J. A., elected Member, 1866, 264.

BIRLEY, H., Original Member, 1847.

BIRMINGHAM Railway Station Roof. *See* Roof, 1854, 79.

Summer Meeting, 1860, 89.

Water Works, pumping engines. *See* Pumping Engines, 1853, 110.

BLACKBURN, I., elected Member, 1856, 250.

BLACKWELL, S. H., elected Member, 1851, Jan., 8.—Council, 1853, 8.—Vice-President, 1854, 5.—1855, 5.—Decease, 1869, 2.—Memoir, 15.

Blast Furnaces, *Paper* on the arrangement of the materials in the blast furnace, and the application of the waste gases, 1852, 191.—Production of carbonic oxide in furnace, 201.—Saving of coal from use of waste gases, 203.—Accumulation of dust in pipes, 203.—Reduction of iron ore when heated in carbonic oxide or carburetted hydrogen, 205.

Boring, *Paper* on Kind's improved system of boring, 1854, 87.

Coking, *Paper* on a new process of open coking, 1860, 188.—Improved yield of coke, 197.—Effect of ammoniacal liquor in preventing scurf in boilers and tuyeres, 198.

Safety Lamp, *Paper* on an improved miner's safety lamp, 1851, Oct., 23.—

Increased light from Eloin lamp, 27.—Strength and durability, 27.

BLADEN, C., elected Member, 1865, 101.—Decease, 1873, 2.—Memoir, 17.

BLAIR, J., elected Member, 1870, 125.

BLAKE, F. W., elected Graduate, 1869, 277.

BLAKE, H. W., elected Member, 1862, 314.

BLAKE STONE-BREAKING Machine. *See* Stone-Breaking Machine, 1864, 20.

BLAST FURNACES, *Paper* on the arrangement of the materials in the blast furnace, and the application of the waste gases, by S. H. Blackwell, 1852, 191.—First attempt to utilise waste gases, 191.—Wrought-iron cylinder in furnace throat, 193.—Closed top with internal cone and cylindrical valve, 194.—Movable closing cone, 195.—White iron caused by pressure from closed top, 197.—Taking off gases from open-topped furnace, 198.—Investigation of action of blast, 199.—Conclusions from use of waste gases, 200.

*Discussion.*—Blackwell, S. H., 200, 201, 202, 203, 204, 205.—Gibbons, B., 201, 202, 204.—Mathews, W., 203, 204.—McConnell, J. E., 201, 205.—Slate, A., 201, 202, 203, 205.—Stephenson, R., 200, 203, 204, 205, 206.

**BLAST FURNACES, *Paper*** on the working and capacity of blast furnaces, by C. Cochrane, 1864, 163.—Different constructions of closed top, 163.—Importance of uniform distribution of gases and materials in furnace, 164.—Absorption of heat by increased height of furnace, 165.—Hot and cold blast, 167.—Diameter of furnace, 171.

*Discussion.*—Anderson, J., 182, 183, 184, 186.—Bennett, P. D., 185.—Bramwell, F. J., 177, 184, 187.—Cochrane, C., 172, 173, 174, 175, 176, 180, 182.—Cowper, E. A., 177, 186.—Ferne, J., 181.—Haden, W., 183.—Napier, R., 172, 173, 175, 176, 182, 187.—Reynolds, E., 174.—Swindell, J. E., 173, 176, 181, 183.

**BLAST FURNACES, CLEVELAND, *Paper*** on the construction of blast furnaces and the manufacture of pig iron in the Cleveland district, by J. G. Beckton, 1864, 249.—Dimensions of furnaces, 249.—Materials used per ton of pig produced, 249.—Chief improvements causing economy, 250.—Different constructions of furnaces, 251.

*Discussion.*—Adamson, D., 253, 254, 255, 259.—Addenbrooke, G., 263.—Bramwell, F. J., 259, 260, 263, 264.—Cochrane, C., 256, 257, 260, 262, 263.—Cowper, E. A., 257, 264.—Napier, R., 254, 255, 258, 262, 263, 264.—Perry, T. J., 264.—Robson, N., 255, 258, 259, 262.—Thomson, G., 255, 256, 261, 264.

**BLAST FURNACES, GOSMONT.** *See* Iron Works, 1863, 225.

**BLAST-FURNACE GAS, *Paper*** on a method of taking off the waste gases from blast furnaces, by C. Cochrane, 1860, 121.—Economy to be effected by taking off waste gases, 121.—Arrangement of materials in furnace, 122.—Closed-top furnace more sensitive to irregularities than open-top furnace, 122.—Mode of taking off gases from closed-top furnace, 123.—Employment of gas in stoves, &c., 124.—Deposit in stoves when furnace fed with Durham coke, 125.—Very little back pressure in closed-top furnace if gas outlets are large enough, 126.

*Discussion.*—Adamson, D., 134.—Cochrane, A. B., 131.—Cochrane, C., 127, 129, 134.—Cowper, E. A., 130, 132.—Fenton, J., 135.—Lloyd, Sampson, 132.—Lloyd, Samuel, 129.—Markham, C., 128, 132.—Mathews, W., 126.—Siemens, C. W., 129.—Snowdon, T., 133, 134.—Swindell, J. E., 131.

**BLAST-FURNACE GAS, *Paper*** on taking off the waste gas from open-topped blast furnaces, by Samuel Lloyd, Jun., 1860, 251.—Failure of early attempt to take off gas from open-topped furnace, 251.—Use of fan to draw off gas for hot-blast ovens, 252.—Trial of closed top; white iron only produced, 253.—Arrangement of central tube descending some distance into materials in furnace, 254.—Cast-iron ends to tube inside furnace much more durable than wrought-iron, 256.—Improved form of apparatus for taking off gas from open-top furnace, 257.—Mode of supplying gas to boilers, 257.—Firebrick casing to cast-iron tube inside



## BLAST-FURNACE GAS (continued).

furnace, 258.—Stoppage on Sundays, 259.—Importance of free escape of gas from furnace, 261.—Increased make of iron after taking off the gas, 262.—Saving in cost of fuel, 263.—Increased amount of ironstone and limestone per ton of iron made, 264.—Open-topped plan of taking off gas preferable to closed top, 264.

*Discussion.*—Bramwell, F. J., 272.—Cochrane, C., 267, 268, 272, 274.—Cowper, E. A., 269, 271, 275.—Fenton, J., 268, 269.—Lloyd, Samuel, Jun., 268, 269, 271, 272, 273, 274, 275.—Markham, C., 274.—Mathews, W., 268, 270.—Maudslay, H., 267, 273, 275, 276.—Siemens, C. W., 274.—Solly, N. N., 269, 271, 272, 273.—Thomson, G., 268.

BLAST-FURNACE GAS, *Paper* on an improved method of taking off the waste gas from open topped blast furnaces, by G. Addenbrooke, 1865, 235.—Close-top and open-top systems of taking off gas, 236.—Different plans on open-top system, 237.—Important not to take off all the gas, 237.—Level of gas openings very important, 239.—Description of improved plan, 241.—Advantages, 245.

*Discussion.*—Addenbrooke, G., 247, 248, 249, 250, 251, 254, 255.—Haden, W., 250.—Jones, J., 255.—Maudslay, H., 251, 255.—Millward, P. A., 247.—Sandberg, C. P., 251.—Solly, N. N., 246.—Swindell, J. E., 247, 248, 249.

BLAST-FURNACE GAS, *Paper* on the further utilisation of the waste gas from blast furnaces, and the economy of coke due to increased capacity of furnace, by C. Cochrane, 1869, 21.—Double-closed furnace top to prevent loss of gas, 22.—Explosion valves in furnace cover, 23.—Amount of gas lost by lowering bell for charging, 23.—Value of gas thus lost, 24.—Effect of increased size of furnace in diminishing consumption of coke, 25.—Calculation of effect of increased size of furnace on heating effect of evolved gas, 25.—Connection between temperature of escaping gas and consumption of coke as influenced by size of furnace, 28.—Calculation of saving in escaping gas from larger furnace, 30.—Maximum limit of size of furnace, 31.—Theoretical minimum consumption of coke, 32.

*Discussion.*—Addenbrooke, G., 35, 36, 41.—Bramwell, F. J., 33, 36, 43.—Cochrane, C., 38, 40, 41.—Cowper, E. A., 37.—Lloyd, Sampson, 40.—Lloyd, Samuel, 37.—Lloyd, W., 41.—Marten, H. J., 40, 43.—McEwen, L. T., 42.—Siemens, C. W., 33, 39, 42.

BLAST-FURNACE GAS, *Supplementary Paper* on the further utilisation of the waste gas from blast furnaces, and the economy of coke due to increased capacity of furnace, by C. Cochrane, 1869, 45.—Correction for calculation of maximum size of furnace, 45.—Rate of driving does not affect economy of fuel, 47.—Conclusions, 48.

## BLAST-FURNACE GAS (continued).

*Discussion.*—Addenbrooke, G., 74.—Bell, I. L., 49, 73, 74.—Bramwell, F. J., 68, 73.—Cochrane, C., 70.—Cochrane, W., 73.—Penn, J., 76.—Siemens, C. W., 62.

BLAST-FURNACE MATERIALS, *Paper* on the preliminary treatment of the materials used in the manufacture of pig-iron in the Cleveland district, by I. L. Bell, 1871, 147.—Fuel, ore, and flux used in Cleveland district, 147.—Loss of volatile portion of coal in coking, 148.—Calcining, 148.—Action of the blast, 149.—Disadvantage of using raw coal, 150.—Action of coke oven, 150.—Breckon and Dixon's coke oven, 151.—Appolt's, 151.—Pernolet's, 152.—Quality of coke made in flued ovens is inferior, 152.—Heat evolved by combustion of coke into carbonic oxide, 153.—Cause of inferiority of soft coke from flued ovens, 153.—Coking coal by combustion of waste gases from furnace, 155.—Reducing the iron ore separately before its introduction into furnace, 156.—Charging furnace with raw ore, 159.—Appropriation of heat in furnace, 161.—Not desirable to use all raw ore, 162.—Employment of raw limestone, 163.

*Discussion.*—Barrett, W., 170.—Bell, I. L., 168, 172.—Cochrane, C., 167, 171.—Cochrane, W., 171.—Jones, E. F., 169, 170.—Lloyd, W., 168.—Marley, J., 171.—Ramsbottom, J., 174.—Siemens, C. W., 165.—Williams, E., 170, 174.

BLAST-FURNACE TUYERE, *Paper* on a gunmetal tuyere for blast furnaces, by N. N. Solly, 1865, 256.—Cast and wrought-iron tuyeres, 256.—Gunmetal tuyere, 257.—Advantages of the gunmetal tuyere, 259.—Improved form of gunmetal tuyere, 261.

*Discussion.*—Addenbrooke, G., 263.—Maudslay, H., 262, 263, 264.—Solly, N. N., 262, 263, 264.

BLAST PIPE. *See* Locomotive.

BLEACHING with Steam Dash Wheel. *See* Dash Wheel, 1856, 239.

BLECKLY, J. J., elected Member, 1867, 59.

BLINKHORN, W., elected Associate, 1867, 60.

BLOOMER, B. G., elected Member, 1869, 276.

BLOWING ENGINE, *Paper* on a blowing engine working at high velocities, by A. Slate, 1850, July, 16.—Early blowing engines, 17.—Regulating tub, 17.—Experimental blowing engine at very high speed, 19.—Proposed high-speed blowing engine, 20.—Cost, 22.—Air-pressure engines for cranes, &c., 23.

*Discussion.*—Cowper, E. A., 25, 26.—Davies, I., 24, 25.—McConnell, J. E., 23, 26.—Robinson, H., 24, 25.—Slate, A., 23, 24, 25, 26.—Smith, W., 25.

BLOWING ENGINE, *Paper* on a new blowing engine working at high velocities, by A. Slate, 1851, July, 37.—Slow speed of ordinary blowing engines,

## BLOWING ENGINE (continued).

37.—Description of new blowing engine, 38.—Trial of working, 39.—Saving in cost, 40.

*Discussion.*—Davies, I., 41.—McConnell, J. E., 40, 41.—Middleton, W., 40, 41.—Slate, A., 40, 41.—Smith, W., 41.

BLOWING ENGINE, *Paper* on a set of six blast engines made for the East Indian Iron Company, by E. A. Cowper, 1855, 154.—Description of engines, 155.—Air valve, 156.—Air cylinder, 156.—Convenience of transport, 157.—Particulars of working, 158.

*Discussion.*—Adams, W. A., 162.—Clift, J. E., 161, 162.—Cowper, E. A., 159, 160, 161, 162.—Fairbairn, W., 158, 159, 160, 162.—Lloyd, Sampson, 161.—Lloyd, Samuel, Jun., 159, 160, 161.—Maudslay, H., 162.

BLOWING ENGINE. *See* Dowlais Ironworks Engines, 1857, 112.

BLOWING ENGINE, *Paper* on the improved compound-cylinder blowing engines at the Lackenby Iron Works, Middlesbrough, by A. C. Hill, 1871, 175.—Description of engines, 176.—Arrangement of cranks opposite each other, 176.—Surface condenser, 177.—Blowing cylinders, 178.—Boilers, 179.

*Discussion.*—Hill, A. C., 180.—Ramsbottom, J., 181.—(Adjourned. *See* following paper, 1872, 274.)

BLOWING ENGINE, *Paper* on the working of the improved compound-cylinder blowing engines and Howard boilers at the Lackenby Iron Works, Middlesbrough, by A. C. Hill, 1872, 274.—Indicator diagrams, description of, 274.—Balanced slide-valves, 275.—Howard boilers, 278.—Joints of pipes, 278.—Cleaning of boilers, 279.—Work done by boilers, 279. (*See* previous paper, 1871, 175.)

*Discussion.*—Bousfield, E. T., 283, 284, 285.—Bramwell, F. J., 286.—Chapman, H., 287.—Claridge, T., 286.—Halpin, D., 281.—Hill, A. C., 281, 282, 285, 287.—Holt, H. P., 282.—Paget, A., 282.—Siemens, C. W., 281, 283, 284, 285, 287.—Thompson, W., 284.—Tweddell, R. H., 283.

BLYTH, A., elected Member, 1862, 314.

BOEDDINGHAUS, J., elected Member, 1863, 246.

BOILER, *Paper* on an improved boiler for marine engines, by A. Lamb, 1852, 9.—Efficiency of marine tubular boilers much diminished by choking and incrustation of tubes, 10.—Description of improved flat-flued boiler, 11.—Particulars of working, 13.—Construction of flues, 15.

*Discussion.*—Allan, A., 17.—Cowper, E. A., 16, 17, 18.—Jones, E., 16.—McConnell, J. E., 16, 17, 18.—Middleton, W., 17.—Shanks, A., 16, 17, 18.

BOILER, *Paper* on a new steam-engine boiler, by T. Forsyth, 1854, 101.—Requirements for proper combustion of coal, 101.—Balanced firegrate, 101.—Fusible plug, 102.—Prevention of corrosion from galvanic currents, 102.—Feed-water heater, 102.

## BOILER (continued).

*Discussion.*—Adams, W. A., 105.—Chellingworth, T. T., 104.—Cowper, E. A., 105.—Fairbairn, W., 103, 104, 105, 106.—Forsyth, T., 103.

BOILER, *Paper* on an improved steam-engine boiler, by H. Wright, 1854, 123.—Description of boiler, 123.—Modification, 124.—Advantages, 124.—Difficulties in application, 125.—Tubular heating surface, 127.

*Discussion.*—Chellingworth, T. T., 131.—Fairbairn, W., 129, 130, 132, 133.—Ferne, J., 131.—Johnson, W. B., 130, 131, 132.—McConnell, J. E., 130, 131, 132.—Prideaux, T. S., 130.—Wright, H., 129, 130, 133.

BOILER, *Paper* on a new duplicate retort steam boiler, by T. Dunn, 1855, 191.—Difficulty of transporting large boilers, 191.—Description of new retort boiler, 192.—Reversing boiler to equalise wear, 193.—Absence of scale, 194.—Particulars of working, 195.

*Discussion.*—Beyer, C. F., 197, 198.—Dunn, T., 196, 197, 198.—Forsyth, T., 196.—Jackson, P. R., 198.—Longridge, R. B., 198.—Ramsbottom, J., 195, 197, 198.—Siemens, C. W., 196.

BOILER, *Paper* on a steam boiler with combined internal and external furnaces, by J. Stephen, 1856, 213.—Description of boiler, 213.—Absence of strain from unequal expansion, 214.—Self acting boiler feed, 214.—Self-acting damper, 214.

*Discussion.*—Dunn, T., 215.—Fairbairn, W., 215.—Harvey, R., 216.—Johnstone, J., 215.—Stephen, J., 215.

BOILER, *Paper* on an improved construction of upright steam boilers, by T. Dunn, 1857, 130.—Boiler with two furnaces, 130.—Evaporative duty, 131.—Boiler with circular down-draught flue, 131.

*Discussion.*—Dodds, I., 133.—Dunn, T., 131, 132, 133.—Fairbairn, W., 132, 133.—Maudslay, H., 131, 132.—Roberts, R., 133.—Tosh, G., 132.

BOILER, *Paper* on steam boilers with small water-space, and Root's tube boiler, by C. Cochrane, 1871, 229.—Early cast-iron boilers, Woolf's, Hancock's, Ogle's, Hancock's flat-chamber boiler, James's annular boiler, 230.—Wrought-iron boilers, Perkins's, Belleville's, 231.—Jordan's, Harrison's, Benson's, 232.—Boilers for steam fire-engines, Field's, 233.—Howard's, Allen's, 234.—Table of water contents of various boilers, 235.—Description of Root's tube boiler, 235.—Facility of repairs, 238.—Firing with waste gas or with coal, 241.—Evaporative duty, 242.—Conditions necessary for satisfactory working of boilers with small water-space, 243.

*Discussion.*—Bell, T., 254.—Clay, W., 253.—Cochrane, C., 244, 249, 251, 252, 254, 255, 256.—Cochrane, W., 245.—Gilkes, E., 251.—Hughes, G. D., 252.—Kesterton, H., 246, 251, 252, 253.—Marshall, F. C., 256.—Marten, E. B., 245.—Olrick, L., 246.—Ramsbottom, J., 244, 253, 256.—Smith, W. F., 255.—Thompson, W., 251.—Whitley, J., 246.—Whitwell, T., 251.

**BOILER, CAST-IRON, *Paper*** on Harrison's cast-iron steam boiler, by Z. Colburn, 1864, 61.—Early high-pressure boilers, 61.—Increase of pressure in locomotives, 62.—Danger of ordinary large wrought-iron boilers, 63.—Description of Harrison's cast-iron boiler, 65.—Weight of boiler, 66.—Bursting strength, 67.—No injury caused by expansion, 70.—Freedom from scale, 72.—Evaporative efficiency, 75.—Experiments on evaporative efficiency, 76.—Machine for facing joints, 78.—Advantages of boiler, 79.

*Discussion.*—Beyer, C. F., 87.—Colburn, Z., 80.—Everitt, G. A., 81.—Hetherington, J. M., 89.—Luders, T. L., 81, 82, 84, 87, 88, 91.—Ramsbottom, J., 80, 82, 91.—Reynolds, E., 88.—Siemens, C. W., 83.—Smith, I., 90.—Webb, F. W., 87.

**BOILER, CAST-IRON, *Paper*** on Miller's cast-iron steam boiler, by J. Laybourne, 1871, 263.—Description of boiler, 263.—Provision for circulation, 264.—Protection of joints from fire, 265.—Particulars of boiler at Isca Foundry, 267.—Boiler at City Flour Mills, Worcester, 268.—Advantages of boiler, 269.—Evaporative duty, 270.—Self-acting feed, 272.

*Discussion.*—Cochrane, C., 273, 276, 279.—Hawksley, T., 276.—Laybourne, J., 273, 276, 277, 278, 279, 280.—Marten, E. B., 275, 277, 278.—Ramsbottom, J., 275, 276, 277, 278, 280.—Taunton, R. H., 277.—Tomlinson, J., 274, 277, 279.—Vallance, F. B., 277.—Williams, R., 278, 279.

**BOILER AND CONDENSER, *Paper*** on a boiler and condenser suitable for extending the Cornish economy, and for preventing boiler explosions, by T. Craddock, 1848, Apl., 5.—Extensive surface and thin metal required for transmission of heat, 6.—Furnace required to be completely surrounded by water, 6.—Sectional area of boiler diminished for rendering high pressure safe, 6.—Quantity of water in boiler diminished for reducing effects of explosion, 6.—High-pressure steam and condensing important for economy, 6.—Improved boiler with increased grate surface and slow combustion, 6.—Facility for generating high-pressure steam, 6.—Continuous supply of pure water for boiler from condenser, 6.

*Discussion.*—Buckle, W., 8, 9.—Craddock, T., 7, 8, 9, 10, 11.—Crampton, T. R., 9.—Cowper, E. A., 7, 8.—Jackson, P. R., 11.—McConnell, J. E., 7, 8, 9, 10, 11.—Stephenson, G., 7, 8, 9, 10.

**BOILER AND CONDENSER. *Supplementary Paper*** on a boiler and condenser suitable for extending the Cornish economy, and for preventing boiler explosions, by T. Craddock, 1848, June, 11.—Advantage of double-cylinder engine for high expansion, 11.—Great strain on engine with single cylinder and heavy flywheel, 11.—Extent of surface required in air condenser, 12.—Comparative light weight of boiler and condenser, 12.

*Discussion.*—Cowper, E. A., 13.—Craddock, T., 12, 13.—McConnell, J. E., 13.—Smith, H., 13.



**BOILER CONSTRUCTION**, *Paper* on the construction and durability of steam boilers, by B. Goodfellow, 1859, 217.—Leakage of tubes in large multitubular boiler, 217.—Large internal flues close together, failure of bottom of boiler, 217.—Internal flues should be reduced in diameter at ends, 218.—Gusset stays superseded by T iron girders across end plate, 219.—Action of expansion of flues in straining boiler shell, 220.—Failure of plain cylindrical boilers at bottom, 220.—Boilers worked day and night, not so much strained as when allowed to cool after day's work, 221.—Multitubular boiler with arched tubes. 222.

*Discussion*.—Adamson, D., 228. — Bastow, S., 224. — Cowper, E. A., 229.—Goodfellow, B., 223, 226, 229.—Harman, H. W., 225.—Longridge, R. B., 222. — Penn, J., 229. — Richardson, W., 227. — Spencer, J. F., 224.

**BOILER, CORNISH**, experiments on evaporative duty of, 1873, 178, 181, 186.

**BOILER, CORROSION OF**, *Paper* on the corrosion of locomotive boilers and the means of prevention, by W. Kirtley, 1866, 56.—Number of explosions, 56.—Grooving in locomotive boilers, 56.—Ordinary construction of boilers, 57.—Particulars of corroded boilers, 59.—Local corrosion at rigid stays, brackets, &c., 60.—Flanged tube-plate, 61.—Cause of corrosion at joints, 61.—Thickened-edge plates, 62.—Welded barrel, 63.—Success of butt-jointed boiler, 64.—Flanging machine for thick-edge plates, 65.—Bending machine, 65.—Welding, 66.—Blocking, 67.—Experiments on welded joints, 67.—Comparative cost of welded and ordinary boilers, 68.—Success of welded boilers, 68.

*Discussion*.—Ferne, J., 74.—Kirtley, W., 69, 78.—Longridge, W. S., 76.—Maudslay, H., 73, 78.—Naylor, W., 69, 76.—Webb, F. W., 72, 73.

**BOILER ECONOMY**, *Paper* on the relative economy and durability of various classes of stationary steam boilers, by R. B. Longridge, 1859, 147.—Proportionate numbers of different boilers now working, 147.—Consumption of fuel per Ind. H. P. per hour, 148.—Evaporative duty of various kinds of boilers, 149.—Area of firegrate and heating surface, 150.—Effect of shape of heating surfaces, 150.—Particulars of experiments on evaporative duty, 152.—Durability, defects, &c., of various forms of boilers, 155.—Plain cylindrical boiler not economical, but very simple and strong, 155.—Cornish boiler, great straining of plate from expansion, 156.—Adamson's flanged seams, 157.—Galloway boiler, very good circulation, 157.—Multitubular boiler, 158.—Table of consumption of fuel, 160.—Table of evaporative duty, 161.—Table of area of heating surface, 162.

*Discussion*.—Bastow, S., 166.—Carrett, W. E., 166.—Goodfellow, B., 165.—Kitson, J., 164.—Longridge, R. B., 163, 164, 166.—Penn, J., 163, 165, 166, 167.

**BOILER EXPLOSION, Paper** on the recent boiler explosion at Dudley, by W. Smith, 1848, June, 14.—Boiler heated by puddling furnace, 14.—Heating surface and steam space, 14.—Evaporation of water, 14.—Steam space too small in proportion to heating surface, 15.—Particulars of the explosion, 15.

*Discussion.*—Cowper, E. A., 16.—McConnell, J. E., 16.—Smith, W., 16.

**BOILER EXPLOSIONS, Paper** on steam boiler explosions and their records, and on inspection as a means of prevention, by E. B. Marten, 1866, 130.—Early sources of information, 130.—Classification of recorded explosions in present century, 132.—Collapse from vacuum, 133.—Erroneous theories of explosion, 134.—Division under two heads, 135.—Early low-pressure boilers, 136.—Cast-iron boilers, 136.—Early wrought-iron boilers, 137.—Plain cylindrical boilers, 140.—Internal tube boilers, 142.—Weakness of large tubes, 144.—Upright boilers, 146.—Boilers with small water-space, 148.—Errors in construction of boilers, 150.—Corrosion, 152.—Accumulation of scurf, 158.—Shortness of water, 160.—Importance of inspection, 164.

*Discussion.*—Bramwell, F. J., 167.—Fairbairn, W., 165.—Fletcher, L. E., 172.—Galloway, C. J., 176.—Kennedy, Col., 167.—Marten, E. B., 165, 170, 178.—Maudslay, H., 169.—Olrick, L., 176.—Richardson, W., 170.—Waller, W., 171.—Whitworth, J., 180.

**BOILER EXPLOSIONS, Paper** on the conclusions derived from the experience of recent steam boiler explosions, by E. B. Marten, 1870, 179.—Three general divisions of explosions, 179.—Faults of construction in various forms of boilers, 179.—Analyses of explosions according to cause, and form of boiler, 180.—Necessity of frequent examination, 181.—Doubtful if boilers ever explode from water coming in contact with red-hot plates, 182.—Sufficient accumulated force in any boiler to cause explosion if suddenly liberated, 183.—Explosions from frequent repair, 184.—Plain cylindrical boilers worked for very long time, 184.—Puddling-furnace boilers, 185.—Greatest number of explosions with Cornish boilers, 186.—Portable-crane boilers, 186.—Boilers of bad form; altered boilers, 187.—Effect of intense heat on boiler plates, 187.—Arrangement of flues, 188.—Domestic boilers, 189.—Faults due to attendants, 190.—Many explosions due to corrosion, 190.—Government inspection not desirable, 191.—Conclusions derived from records of explosions, 193.—Tables of boiler explosions, 194 to 199.

*Discussion.*—Adamson, D., 206.—Bouch, W., 217.—Bramwell, F. J., 203, 218.—Crampton, T. R., 204.—Ferguson, H. T., 210.—Fletcher, L. E., 200.—Hawksley, T., 199, 200, 203, 204, 216, 218.—Longridge, R. B., 202, 203, 204.—Marten, E. B., 199.—Olrick, L., 211.—Paget, F. A., 210.—Richardson, W., 213, 216.—Smith, W. F., 211, 216.

**BOILER, HIGH-PRESSURE, *Paper*** on high-pressure boilers, and on boiler explosions, by W. Smith, 1848, July, 11.—Ordinary boilers for puddling furnaces not safe for high pressure, 11.—Improved form of boiler with two tubes under it, 12.—Many boilers very liable to accident, 13.—Bad form for standing increased pressure put on for extra work, 13.—Defective steam and water indicators, 13.—Neglect in cleaning boilers causes risk of explosion and constant expense in repairs and extra fuel, 13.

*Discussion.*—Buckle, W., 14.—Cowper, E. A., 15, 16.—Fothergill, B., 15, 16.—Gibbons, B., 14, 17.—McConnell, J. E., 15.—Ramsbottom, J., 16.—Robinson, H., 16.—Smith, H., 14.—Smith, W., 14, 15, 16.—Stephenson, G., 17.

**BOILER, HIGH-PRESSURE, *Paper*** on a new construction of high-pressure steam boiler, (Benson's,) by J. F. Spencer, 1859, 264.—Description of boiler with mechanical circulation, 265.—Circulating pump, 266.—Arrangement of tubes, 267.—Safety and durability, 268.—Economy of fuel, weight, space, cost, and repair, 269.—Rapidity of raising steam from cold water, 270.

*Discussion.*—Benson, M., 274, 277, 278.—Cowper, E. A., 273.—Inshaw, J., 270, 271, 277.—Jones, E., 277.—Manning, J., 271.—Maudslay, H., 271, 278.—Spencer, J. F., 272, 273, 277.

**BOILER, HIGH-PRESSURE, *Paper*** on Benson's high-pressure steam boiler, by J. J. Russell, 1861, 30.—Arrangement of tubes, 30.—Circulating pump, 31.—Removal of incrustation, 32.—Bends for connecting tubes together, 33.—Special advantages of boiler, 34.—Evaporative duty, 37.—Starting and stopping the engine, 37.—Reducing valve, 38.

*Discussion.*—Benson, M., 41, 42.—Everitt, G. A., 39.—Fenton, J., 39.—Fothergill, B., 42.—Masselin, A., 41.—Richardson, W., 39, 40.—Russell, J. J., 39, 40.—Siemens, C. W., 40.

**BOILER, HIGH-PRESSURE, *Paper*** on a boiler, engine, and surface condenser, for very high-pressure steam with great expansion, by A. W. Williamson and L. Perkins, 1861, 94.—Working pressure of 500 lbs. per square inch, 94.—Boiler, 95.—Flues for heating cylinders, 96.—Evaporative power, 96.—Strength of boiler, 96.—Engine, 97.—Indicator diagrams, 98.—Condensation in cylinders, 99.—Suggestions for larger engines with several cylinders, 100.—Surface condenser, 102.

*Discussion.*—Bouch, W., 104.—Bramwell, F. J., 107.—Cochrane, J., 106.—Cowper, E. A., 103, 104, 105, 108.—May, W., 105.—Murphy, J., 107.—Perkins, L., 104, 105, 107.—Smith, M., 105.—Weild, W., 105.—Williamson, A. W., 106.

**BOILER LINING, *Paper*** on Whittle's plan for preventing deposit and incrustation in steam boilers, by G. Addenbrooke, 1871, 48.—Great loss of heat from incrustation, 48.—Action of floury precipitate, 50.—Cause of



# BOILER LINING (continued).

explosion, 50.—Principle of Whittle's plan, 51.—Blowing-off not sufficient to clean boiler, 53.—Much mud settles in the lining, which would not settle at all in ordinary boiler, 53.—Old incrustation removed, 54.—Economy of fuel, 54.—Plates protected from overheating even when water much below proper level, 55. Application to internal-flue boilers, 55.

*Discussion.*—Addenbrooke, G., 56, 61.—Bramwell, F. J., 57.—Cowper, E. A., 59, 60, 62.—Fenby, J. B., 56.—Lloyd, Sampson, 57.—Lloyd, W., 61.—Marten, E. B., 58.—Perry, F. C., 62.—Ramsbottom, J., 61, 62.—Robinson, J., 59, 60.—Whittle, W., 57, 60, 61, 62.

**BOILER, LOCOMOTIVE, *Paper*** on an improved locomotive boiler, by J. Ramsbottom, 1849, July, 3.—Blast pipe and boiler only slightly enlarged with great increase in size of locomotives, 4.—Increased quantity of air to be forced through fire, 4.—Experiments on blast required to overcome resistance of tubes, 5.—Boiler proposed to be filled with tubes, and separate steam chamber above, 6.—Copper firebox with arched roof avoiding ordinary heavy stay-bars, 6.—Circulation maintained in steam chamber by rising current at firebox, 7.

*Discussion.*—Allan, A., 9.—Beyer, C. F., 8, 10, 11.—Cowper, C., 8, 9.—Cowper, E. A., 8, 10.—Gibbons, B., 9.—McConnell, J. E., 8, 9, 10, 11.—Slate, A., 8, 10, 11.

**BOILER, LOCOMOTIVE, *Paper*** on an improved steam boiler for locomotive and other engines, by A. Allan, 1856, 233.—Description of locomotive boiler, 233.—Firebox, 233.—Perforated fire bridge, 234.

*Discussion.*—Allan, A., 235.—Fairbairn, W., 235.—Fothergill, B., 235.—Ramsbottom, J., 235.—Whitworth, J., 235.

**BOILER, LOCOMOTIVE, *Paper*** on an improved locomotive boiler, by W. M. Neilson, 1856, 236.—Description of boiler, 236.—Firebox with depressed crown, 236.—Coal-burning arrangement, 237.

*Discussion.*—Fenton, J., 238.—Rankine, W. J. M., 238.—Tosh, G., 238.

**BOILER, MECHANICAL FIRING, *Paper***, on the mechanical firing of steam boilers, by J. Daglish, 1869, 155.—Experiments with Juckes's firegrate at Rainton Colliery, 155.—Experiments with hand-firing, and Stanley's, Vicars', and Juckes's firegrates at Seaham Colliery, 157.—Comparison of Cornish and plain cylindrical boilers, 162.—Tables of results of experiments, 164 to 171.

*Discussion.*—Armstrong, Sir W. G., 175, 180.—Bell, I. L., 179.—Crampton, T. R., 175.—Daglish, J., 173, 175.—Hawksley, T., 172, 174.

**BOILER, MULTITUBULAR**, greater evaporative duty than Cornish, 1873, 175.

**BOILER SAFETY-VALVE.** *See* Safety-Valve.

**BOILER TUBES.** *Paper* on the composition and durability of locomotive boiler tubes in reference to coal-burning, by G. A. Everitt, 1867, 46.—Three qualities of copper; one since abandoned, 46.—Failure of new marine boiler tubes, 47.—Admiralty method of testing copper for brass tubes, 48.—Different alloys for tubes, 49.—Average duration of tubes, 49.—Thickness of tubes, 50.—Iron tubes with brass ends, 51.—Tubes should be stored in dry place, 52.

*Discussion.*—Cowper, E. A., 53, 57.—Crosby, S., 54.—Everitt, G. A., 52, 54, 56.—Ferne, J., 56.—Muntz, A., 56.—Penn, J., 55, 57.

**BOISTEL, G.**, elected Member, 1872, 26.

**BOLITHO, T. S.**, Ore-dressing Machinery, decrease in production of tin in Cornwall, 1873, 146.—Further improvements wanted in ore-dressing, 146.—Separating wolfram by soda-ash, 147.—Great amount of tin washed away in slimes, 147.—Waste sand left for several years oxidises and allows separation of tin, 148.—Brunton's separator very ingenious but not successful, 149.—Brunton's experiment on separating metallic copper and tin, 149.

**BOLTON, F. J.**, Major, elected Member, 1872, 119.

**BONE MANURE MACHINE.** *Paper* on a machine for preparing bone manure, &c., by W. Buckle, 1843, July, 6.—Bones reduced to state of meal prepared for rapid solubility, 6.—Rapidity of effects of phosphate of lime depends on solubility, 6.—Other mills merely crush bones into lumps, remaining long undecomposed, 6.—Successful results of fine bone-dust obtained from new machine, 6.—Stampers used instead of ordinary rollers, 7.—Arrangement of stampers and elevators, 7.—Comparative results of bone-dust and stable manure, 7.—Great improvements in cultivation of the Bedford Level fen district, 8.—Drains deepened and straightened, and banks strengthened by puddled gault walls, 8.—Steam engines for draining in place of wind-mills, 9.—Claying the land in place of paring and burning the peat surface, 9.

*Discussion.*—Buckle, W., 11.—Cowper, E. A., 11.—Gibbons, B., 11.—Robinson, H., 11.

**BOREL, P.**, Dredgers for Suez Canal, *Paper* on the steam dredgers employed in the excavation of the Isthmus of Suez Canal, 1867, 192.—Conveying machines to working places, 208.—Jetties at Port Said, 208.—Working of dredgers, 209.—Cutting at El Guisr, 210.—Artificial lakes, 211.—Entrance to Red Sea at Suez, 213.—Sand storms offer no inconvenience to traffic, 215.—Drifting of sand at Port Said, 217.—Difference of level of two ends of canal, 217.

**BORING Locomotive Cylinders.** *Paper* on boring and fitting up cylinders for locomotive engines, by C. F. Beyer, 1848, Apl., 3.

*Discussion.*—Fenton, J., 3.—Fothergill, B., 3.—McConnell, J. E., 3.—Stephenson, G., 3.

**BORING**, *Paper* on Kind's improved system of boring, by S. H. Blackwell, 1854, 87.—Importance of boring, 88.—Description of Kind's system, 89.—Free-falling tool, 90.—Boring cores, 90.—Table of particulars of bore-holes, 91.—Abstract of register of boring at Kreutsberg, 92.—Monthly cost of boring, 93.

*Discussion.*—Blackwell, S. H., 93, 94, 95.—Cowper, E. A., 95.—Fairbairn, W., 93, 94, 96.—Lloyd, Sampson, 94.—McConnell, J. E., 94, 95.—Siemens, C. W., 95.

**BORING MACHINE**, for Rock, *Paper* on a rock-boring machine, by G. Low, 1865, 179.—Boring cylinder, 180.—Valve and cam, 180.—Rotation of tool, 181.—Advance of tool, 182.—Fixing tool in piston-rod, 184.—Form of cutters, 184.—Frame and carriage, 185.—Air-compressing engine, 186.—Water-pistons, 187.—Boring in Roundwood tunnel, 188.—Rate of boring, 189.—Points of advantage in boring machine, 190.

*Discussion.*—Andrews, J., 195, 196, 197, 198.—Cochrane, C., 199.—Downing, Dr., 191, 192, 193, 194.—Gray, Sir J., 198.—Harman, H. W., 193.—Leigh, E., 193.—Low, G., 191, 194.—Murphy, J., 194, 197.—Napier, R., 191, 192, 196, 200.—Neville, P., 200.—Newton, W. E., 193, 197.—Waterhouse, T., 194.

**BORING WELLS**, *Paper* on the machinery for boring artesian wells, by L. Dru, 1867, 174.—General dimensions of artesian wells, 174.—Boring apparatus for large wells, 175.—Boring tool, 175.—Free-falling tools, 176.—Boring rods, 178.—Scoop, 179.—Delivery of water from artesian wells, 181.—Kind's stuffing-box for tubing shafts bored through watery strata, 181.

*Discussion.*—Bramwell, F. J., 187.—Clay, W., 187.—Cochrane, C., 184, 189.—Dru, L., 182, 183, 184, 186, 188, 189, 190.—Fairbairn, W., 189.—Lancaster, J., 183, 184.—Mallet, R., 189, 190.—Mather, W., 185, 187.—Penn, J., 190.

**BORING WELLS**, *Paper* on well-boring and pumping machinery, by W. Mather, 1869, 278.—Chinese system of boring, 278.—Free-falling tool, 279.—Rope boring, description of machinery, 282.—Boring-head, 284.—Shell pump, 285.—Mode of working, 286.—Particulars of bore-holes, 288.—Table of bore-holes, with particulars, 291.—Grappnels &c. for accidents, 293.—Tubes and tube-forcing apparatus, 296.—Pumping machinery, 300.—Improved bell-crank pumps, 302.

*Discussion.*—Beckett, H., 306, 310.—Cowper, E. A., 307.—Lloyd, Sampson, 310.—Longridge, W. S., 309.—Mather, W., 304, 305, 308, 309, 310.—Ramsbottom, J., 308, 309, 310, 311.—Whittem, T. S., 310.

**BORRIE**, J., elected Member, 1869, 276.

**BOUCH**, T., elected Member, 1862, 47.

**BOUCH**, W., elected Member, 1858, 79.

Boiler Explosions, safety of locomotive boilers, 1870, 217.

BOUCHERIE's Process for Preserving Timber. *See* Timber, 1856, 196.

BOURDON, E., Pressure Gauge, 1852, 91.

Barometer, &c. *See* Pressure Gauge, 1852, 141.

BOURNE, J., Railway Switch, very successful working of Thompson and Nicholson's switch, 1858, 173.

BOUSFIELD, E. T., Howard Boilers, &c., horizontal tubes better than vertical, 1872, 283.—Tubes readily removed, 283.—Great facilities for cleaning, 284.

BOVILL, G. H., Original Member, 1847.—Decease, 1869, 2.—Memoir, 16.

Screw Propeller, *Paper* on a new improved screw propeller, 1852, 163.

Surface Condenser, horizontal tubes best, 1862, 117.—Brazen tubes frequently leaky, 118.

BOWER, A., elected Member, 1870, 228.

BOWER, J. W., elected Member, 1858, 79.

BOWLER, S., elected Member, 1848.

BOWMAN, R., elected Member, 1850, Apl., 30.

BOXER CARTRIDGE Manufacture. *See* Cartridge Machinery, 1868, 105.

BOYD, N., elected Member, 1862, 93.

BOYD, W., elected Member, 1869, 77.

BRADBURY, C. J., elected Member, 1873, 87.

BRAGGE, W., elected Member, 1854, 49.

BRAMWELL, F. J., elected Member, 1854, 110.—Council, 1864, 18.—1867, 17.—Vice-President, 1868, 19.—1869, 19.—1870, 18.—1871, 20.—1872, 25.—1873, 24.

Blast Furnaces, preferable not to close furnace mouth completely, 1864, 177.—Importance of breaking the materials to uniform size, 178.—Success of regenerative hot-blast stoves, 179.—Mechanical tests for iron preferable to chemical, 184.—Illustration of action of increased capacity of furnace, 1869, 68.

Boilers, evaporative duty over-estimated from effects of priming, 1861, 107.—Lancashire boiler very safe and successful, 1866, 168.—Sand makes good covering, 169.—Howard's "quicksilver" engine, effects of explosion very small, 1870, 218.—Perkins circulators, 1871, 57.—Whittle lining very good, 58.

Coal-Cutting Machine, full pressure throughout stroke without expansion, 1872, 220.—Lap causes air to be let in late, 221.

Colliery Working, Midland, steam in excess of boiler pressure when engine reversed, 1870, 162.—Excess pressure due to momentum of steam, 165.

Condenser, Ejector, experiments on working of condenser, 1872, 268.

Corn Mill, Buchholz, huller very successful; glass blades for huller, 1872, 236.—Superiority of fine white flour, 236.

BRAMWELL, F. J. (continued).

Corn Warehousing Machinery, revolving screw in wire casing for cleaning grain, 1869, 225.—Pneumatic system of lifting grain, 225.

Counter-pressure Steam Break, particulars of trials on South Western Railway, 1870, 41.—Successful for regular working of trains. 43.—Rise of pressure above that of boiler, 44.

Disintegrator, experiments on disintegrating flour mill, 1872, 40.—Great saving over power required for millstones, 41.—Increase of power spent in churning air with increased velocity, 47.—Flour much cooler than when ground by millstones, 51.—Pestle system of grinding and dressing grain, 51.—Grain steamed and slightly crushed before disintegrating, 52.

Docks, Floating, *Paper* on floating docks and other arrangements for affording access to ships for external repairs, 1867, 80.—Masonry dock used to contain the American sectional floating dock, 109.—More work in expelling water from pontoons by forcing in air than by pumping, 110.—Difficulty in working the box floating dock, 111.

Engines, Portable, for Mining, diagrams from portable engines show less expausion than Cornish engines, 1873. 194.—Particulars of trials of portable engines in 1872 at Cardiff. 195.—One kind of boiler as good in evaporative duty as the other, if properly proportioned, 196.—Important to ascertain by analysis the ultimate evaporative power of the fuel, 196.—Loss of power by engine-friction. 198.

Governor, Chronometric, perfectly satisfactory for rolling mills. 1866, 35.—Only very slight variation in speed permitted by governor, 36.

Gunstock Machinery, cost of fitting gun together, 1862, 339.

Hot-Blast Stoves, simple expedient for keeping temperature of blast constant. 1870, 100.—Increased size of blast furnace will not cool gases beyond certain limit, 100.

Hydraulic Machinery, low-pressure hydraulic hoist, 1868, 39.—Pneumatic or exhaustion system of transmitting power, 39.

Injector, explanation of action, 1860, 49.

Iron Works, exhausting fans to aid in drawing off the gas from blast furnaces, 1863. 234.—Boilers heated by waste gas more durable than when fired with coal, 240.

Knitting Machine, breakage of sinkers due to sudden change of form. 1870. 142.—Early knitting machines, 142.

Magnetic Water Gauge, Du Trembley's magnetic gauge, 1860. 87.

Marine Engines, *Paper* on the progress effected in economy of fuel in steam navigation considered in relation to compound-cylinder engines and high-pressure steam, 1872. 125.—Diminution in consumption of coal, 163.—Examples of Parliamentary enquiries leading to erroneous



BRAMWELL, F. J. (continued).

expressions of opinion, 181.—Advantages of results from trial trips, 182.—Desirability of continuous indicator, 182.—Compound cylinders probably most advantageous in expansion, 182.—Diminution of priming at high pressures, 183.—Friction of expansion slides, 183.—Shock on crank from high steam pressure, 184.

Mining Machinery, method of raising water by exhausted air, 1859, 36.

Ore-Dressing Machinery, use of current of air in preparing beaver fur, 1873, 150.—Difficulty in separating substances of dissimilar sizes and gravities, 151.

Packing for Pistons, Ramsbottom's rings very satisfactory for steam hammers, 1862, 326.

Plate Glass Manufacture, success of Siemens furnaces, 1863, 217.—Plates handled several times in polishing, &c.; liability to fracture, 217.—Revolving grinding table a great improvement, 218.—Undulations of surface produced in annealing, 218.—Grinding the emery, 221.

Polished Sheet Glass, emery-sorting apparatus works very well, 1863, 279.—Similar principle of sorting applied to other substances, 279. \*

Pump, Horizontal V, no advantage over ordinary pump, 1864, 39.

Pumping Engine, Cornish engine more liable than rotary to damage from shock when pump only partly filled with water, 1863, 263.—Comparison of duty and coal consumption per H.P., 1867, 243.—High duty of Crossness engines, 243.—Duty of portable engines, 244.—Pressure required to open flap valves, 245.

Safety Valve, reduction of pressure in neighbourhood of valve, 1865, 229.

Scraper for Torquay Water Works, position of scraper easily ascertained by sound, 1873, 231.—Great amount of stuff scraped off, 231.—Great increase in delivery of water just after scraping, due to smoothing of pipe surface, 231.

Shaping Machine, effect of defective balancing in wheels, 1866, 285.

Slide-Valve, Balanced, engine with balanced valves easily reversed under steam, 1871, 43.—Great saving in amount of power required to work valves, 44.—Application of double-port valves to locomotives, 45.

Steam Cultivation, ingenious adjustment of clip drum, 1865, 92.—No real objection to traction engines on roads, 92. \*

Steam Hammer, top steam very desirable, 1860, 288.—Rigid attachment of hammer to piston-rod best, 288.

Superheated Steam, superheating effects further saving than is due to interception of waste heat, 1860, 30.—Saving of feed and injection water from absence of priming, 34.

Surface Condenser, experiments on surface condensation, 1862, 113.



BRAMWELL, F. J. (continued).

Towing Canal Boats, various plans of towing with a fixed hold for applying power to, 1869, 265.—Whole of power utilised in wire-rope towing, 266.

Vacuum Gauge, *Paper* on an improved vacuum gauge for condensing engines, 1851, Jan., 27.

Ventilating Fan, experiment showing that gauge-orifice should directly face stream of air, 1871, 34.

Ventilation, Mechanical, importance of washing air to cleanse it for ventilation of buildings, 1863, 202.

Wrought-Iron Lighthouse, similar construction adopted in Crumlin Viaduct, stood firm for several years, 1861, 28.

BRANSON, G., elected Honorary Member, 1848.

BRANSON, J. W., elected Honorary Member, 1864, 60.

BRAY, E., elected Member, 1856, 79.

BREAK BLOCKS, Cast-Iron, 1871, 207, 210.

BREAK DRUMS, *Paper* on the break drums and the mode of working at the Ingleby incline on the Rosedale branch of the North Eastern Railway, by J. A. Haswell, 1871, 200.—Description of incline, 200.—Description of break drums, 201.—Break straps, 202.—Steel wire ropes, 202.—Arrangement at top of incline, 203.—Particulars of working, 203.

*Discussion.*—Appleby, C. J., 209.—Cochrane, C., 211.—Cochrane, W., 207.—Cowper, E. A., 209.—Fletcher, H. A., 206.—Fletcher, J., 210.—Gilkes, E., 210.—Hackney, W., 210.—Haswell, J. A., 204, 205, 206, 207, 209, 211.—King, W., 206.—Leigh, E., 206.—Ramsbottom, J., 205, 211.—Siemens, C. W., 208.—Taylor, J., 207.

BREAK, RAILWAY, *Paper* on an improved break for railway carriages, by W. Handley, 1852, 19.—Ordinary break, 19.—Lee's break, 20.—Adams' sledge break, 20.—Handley's improved break, 21.—Advantages, 22.

*Discussion.*—Adams, W. A., 23, 24, 25, 26.—Clift, J. E., 24.—Cowper, E. A., 25, 26.—Goodfellow, B., 25, 26.—Henson, H. H., 23.—Marshall, W. P., 23, 24, 25, 26.—McConnell, J. E., 23, 27.—Peacock, R., 24, 26, 27.

BREAK, RAILWAY, *Paper* on the retardation and stoppage of railway trains, by W. Fairbairn, 1853, 156.—Heath's break, 156.—Trials of do., 157.—Description of Newall's break, 158.—Coupling between carriages, 159.—Objects gained, 160.—Table of trials, 161.—Newton's break, 162.—Molson's break, 163.

*Discussion.*—Dyer, W., 165.—Fairbairn, W., 163, 164.—Newall, J., 164.—Newton, S., 165.—Perring, J. S., 164.

BREAK, STEAM, *Paper* on increased break power for stopping railway trains, by A. Allan, 1859, 230.—Arrangement for throttling exhaust steam, 230.—Steam break, 231.—Use of throttle-valve in controlling train, 232.—Back pressure when throttle-valve closed enables engine to be

## BREAK. STEAM (continued).

reversed, 232.—Trials of steam break, &c., 233.—Tables of results of trials, 234, 235.

*Discussion.*—Allan, A., 235, 236.—Morrison, R., 236.—Penn, J., 237.

BREAK, STEAM, COUNTER-PRESSURE, *Paper* on Le Chatelier's plan of using counter-pressure steam as a break in locomotive engines, by C. W. Siemens, 1870, 21.—Reversal of valve-gear on emergencies, 21.—Description of diagrams of ordinary and counter-pressure working, 22.—Apparatus for injecting water into exhaust passages of cylinders, 25.—First trials with mixed injection of steam and water, 26.—Subsequent adoption of water injection alone, 27.—Screw reversing gear most convenient, 28.—Calculation of heat required to vaporise water jet, 29.—Heating effect of compression in cylinders when running reversed, 30.—Extensive application to French locomotives, 31.—Working of inclines, 33.—Steep inclines in France, 34.—Advantages of counter-pressure working instead of breaks, 35.

*Discussion.*—Beattie, W. G., 46.—Bramwell, F. J., 40, 56.—Brown, R., 58.—Cowper, E. A., 49, 56.—Holt, F., 54.—Kirtley, W., 47.—Moorsom, W. M., 50, 57.—Ramsbottom, J., 38, 51, 58.—Robinson, J., 54.—Siemens, C. W., 37, 39, 55, 57.—Vaughan, C., 50.

BREAKING MACHINE for Stone. *See* Stone-breaking machine, 1864, 20.—Stone-crushing machinery, 1860, 234.

BREECH-LOADING RIFLES. *See* Rifles, 1871, 92.

BREEDEN, J., elected Member, 1868, 20.

BRICK-MAKING MACHINE, *Paper* on the American dry-clay brick-making machine, by E. Jones, 1853, 148.—Description of machine, 148.—Rate of working, 149.—Cost compared with hand brick-making, 149.

*Discussion.*—Dyer, W., 150.—Fairbairn, W., 150, 151.—Jones, E., 150, 151.—Smith, H., 150.

BRICK-MAKING MACHINE, *Paper* on a dry-clay brick-making machine, by B. Fothergill, 1859, 42.—Arrangement of works, 42.—Pulveriser, 42.—Brick press, 43.—Action of cams and pistons, 44.—Rate and cost of production, 45.

*Discussion.*—Adams, W. A., 46, 47, 50.—Cowper, E. A., 50.—Fothergill, B., 46, 47, 48, 49, 51.—Marshall, W. P., 48.—May, C., 47, 48, 50.—Muntz, G. F., 48.—Penn, J., 49, 51.—Richardson, W., 49, 50, 51.—Siemens, C. W., 51.—Smith, W., 46.—Whitworth, Sir J., 49, 51.

BRICK-MAKING MACHINE, *Paper* on Oates' brick-making machine, by J. E. Clift, 1859, 249.—Principles of action of various brick-making machines, 249.—Description of Oates' machine, 250.—Motion of mould block, 251.—Escape pipe for preventing over-pressure in chamber, 252.—Planing faces of brick, 253.—Rate of working, 253.—Burning the bricks, 254.—Comparative strength of machine and hand-made bricks, 254.

## BRICK-MAKING MACHINE (continued).

*Discussion.*—Clift, J. E., 255, 257, 260, 261.—Cowper, E. A., 256, 258, 263.—Goold, Capt., 253, 259, 260.—Hawkes, W., 260, 261.—Lloyd, Sampson, 257.—Longridge, H. G., 255, 259.—Manning, J., 256, 259.—Maudslay, H., 262, 263.—May, C., 257, 260, 261.—May, W., 259.—Oates, J. P., 256, 261, 262, 263.

BRIDGE, HYDRAULIC SWING, *Paper* on the hydraulic swing bridge for the North Eastern Railway over the River Ouse near Goole, by Sir W. G. Armstrong, 1869, 121.—Three classes of hydraulic movable bridges, 121.—Particulars of various bridges, 122.—Description of Ouse bridge, 123.—Turning machinery, 124.—Securing ends of swinging portion in position for trains to pass, 125.

*Discussion.*—Armstrong, Sir W. G., 129, 131, 132.—Bell, I. L., 131.—Chapman, H., 129.—Cowper, E. A., 130.—Gooch, T. L., 130.—Hodgson, R., 127.—Olrick, L., 129.—Ramsbottom, J., 128.—Westmacott, P. G. B., 130.

BRIDGE, INDIAN RAILWAY, *Paper* on the construction and erection of iron piers and superstructures for railway bridges in alluvial districts, by Lt.-Col. J. P. Kennedy, 1861, 171.—Extent of British exports to India, 171.—General nature of Indian railways, 172.—Construction of bridge piers in tidal rivers, 174.—Bridge spans and girders, 175.—Bridge piers for deep inland rivers, 175.—Strength of girder bridges, 177.—Rapidity of erection, 178.—Importance of uniformity throughout construction of bridges, 179.—Cost of construction of railways, 180.—Secondary railways or tramways, 181.

*Discussion.*—Armstrong, Sir W. G., 184, 188, 189, 192.—Bellhouse E. T., 186.—Bessemer, H., 185.—Cochrane, A. B., 188.—Harman, H. W., 190, 191.—Kennedy, Lt.-Col. J. P., 182, 183, 184, 185, 187, 188, 189, 190, 191, 192.—Markham, C., 183, 184.—Maudslay, H., 192.—Spencer, J. F., 189.

BRIDGE PIERS, INDIAN, *Paper* on the apparatus used for sinking piers for iron railway bridges in India, by J. F. Strong, 1863, 16.—General description of Jumna Bridge, 16.—Sinking pier foundations in deep water, 17.—Scoop for excavating sand, 18.—Rate of sinking cylinders, 20.—Building the piers, 21.—Construction of bridge, 22.—Rise of river in floods, 23.

*Discussion.*—Beyer, C. F., 23, 25, 28, 30, 33.—Branwell, F. J., 27, 28, 31.—Cowper, E. A., 29, 31.—Ferne, J., 27.—Gilkes, E., 27, 28, 32, 33.—Harman, H. W., 24, 26, 28.—Strong, J. F., 23, 25, 26, 27, 28, 30, 31, 32, 33.—Woods, H., 25, 31.

BRIDGE, SUSPENSION, *Paper* on an improved suspension bridge, "Inverted Arch," by E. A. Cowper, 1847, Oct., 1.—Ordinary suspension bridge least costly, but not competent for carrying a railway, 1.—Chain assumes different curves with moving load, 2.—Boiler-plate chain proposed, deep enough to include extreme curves of strain, 3.—Proposed construction of suspension bridge, 4.—Inverted-arch bridge, 5.

BRIDGE, WIRE-ROPE, *Paper* on a wire-rope bridge at the Landore Steel Works for conveying materials across a navigable stream, by W. Hackney, 1870, 249.—Requirements to be met, 249.—Construction of bridge, 249.—Mode of working, 250.—Lowering of bridge for passage of vessels, 250.—Anchorages and couplings, 251.—Raising of bridge, 251.—Mode of fixing ends of wire, 252.—Mode of hooking-on trucks, 252.—Working load; rate of working, 253.—Suggestions for modifying bridge to meet other circumstances, 254.

*Discussion*.—Eaton, R., 256.—Fowler, G., 256.—Hackney, W., 255, 256.

Lloyd, Sampson, 257.—Siemens, C. W., 255, 257.

BRIERLY, H., elected Member, 1861, 14.

BROAD, R., elected Member, 1848.

BROCK, W., elected Member, 1865, 53.

BROCKBANK, W., elected Honorary Member, 1863 114.

BROGDEN, A., elected Member, 1852,

BROGDEN, H., elected Member, 1852, 9.

BROWN, A. B., elected Member, 1866, 55.

BROWN, B. L., Regenerative Gas Furnace, successful for tube welding, 1862, 42.

BROWN, C. J., elected Member. 1866. 17.

BROWN, G., elected Member, 1865, 101.

BROWN, H., elected Member, 1863, 15.

BROWN, JAMES, Original Member, 1847.

BROWN, JOHN (Sheffield), elected Member, 1850, July, 43.

Steel Rails and Armour Plates, *Paper* on the manufacture of steel rails and armour plates, 1861, 121.—Durability of steel rails, 126.—Cost of steel rails, 127.—Experiments on strength of steel rails, 127.—Rate of making armour plates, 128.—Experiments on armour plates, 129.—Soft tough plates necessary to resist heavy shot, 130.

BROWN, JOHN (Barnsley), elected Member, 1855, 97.

Tubbing, Cast-Iron, *Paper* on cast-iron tubbing used in sinking shafts, 1861, 193.—Tubbing not usually required at great depths, 202.—Lined with brickwork in upcast shafts, 202.

BROWN, JOHN (Darlington), elected Member, 1856, 6.

BROWN, R., elected Member, 1853, 75.

Counter-Pressure Steam Break, former plan of throttling exhaust for descending inclines without reversing, 1870, 58.

Hot-Blast Ovens, mixture of various hot-blast irons gives better testing results than cold-blast iron, 1859, 107.

BROWN, W. S., elected Member, 1863, 57.—Decease. 1865, 2.—Memoir, 13.

BROWNE, B. C., elected Member, 1869, 276.

BROWNE, W. R., elected Member, 1869, 119.

Riveted Joints, *Paper* on the strength and proportions of riveted joints,

BROWNE, W. R. (continued).

with the results of some recent experiments, 1872, 53.—Strength of iron used must be ascertained before applying formulæ for proportioning rivets, 92.—Steel-plates cut iron rivets more rapidly than iron plates, 93.—Chain-riveting preferable to zigzag riveting, 93.—Good drilled holes easier to make than good punched holes, 94.—Plates can be made as strong across grain as with grain, 94.—Diagonal-jointed boiler advantageous, 94.

BRUCE, W. D., elected Member, 1867, 18.

BRUNEL, H. M., elected Member, 1873, 250.

BRUNLEES, J., elected Member, 1870, 61.

BRUNNER, H., elected Member, 1872, 119.

BRUSSELS CARPET LOOM. *See* Carpet Weaving, 1868, 195.

BRYANT, F. W., elected Member, 1865, 101.

BRYHAM, W., elected Member, 1866, 17.

BUCHHOLZ CORN MILL. *See* Corn Mill, Buchholz, 1872, 225.

BUCKLE, W., Original Member, 1847.—Council, 1847.—1848.—1849, Jan., 9.  
—1850, Jan., 5.—1854, 5.

Bone Manure Machine, *Paper* on a machine for preparing bone manure, &c., 1848, July, 6.—Weight and speed of stampers, 11.—Bones broken by light smart blow, not crushed by heavy weight, 11.—Great saving of power by not using crushing rollers, 11.

Fan Blast, *Paper* on a series of experiments relative to the fan blast, 1847, May, 3.—*Supplementary Paper* on the fan blast, 1847, Oct., 4.

High-Pressure Boilers, great loss from upper part of boilers being exposed to weather, 1848, July, 14.

Murdock, W., *Paper* on the inventions and the life of William Murdock, 1850, Oct., 16.

Safety Buffer, *Paper* on Chesshire's safety buffer, 1848, Apl., 15.—Shock conducted to luggage van at end, 16.

Starting Apparatus, clutch engaged and disengaged without noise or concussion, 1849, Jan., 20.—Objections to cap and screw clutch, and to crab and cone clutch, 20.

BUCKLEY, R. B., elected Member, 1873, 250.

BUCKTON, G., elected Member, 1868, 103.

BUCKTON, J., elected Member, 1859, 53.

BUDA LIGHTHOUSE. *See* Wrought-Iron Lighthouse, 1861, 15.

BUDDEN, W. H., elected Honorary Member, 1858, 80.

BUDENBERG, A., elected Member, 1872, 119.

BUFFER, *Paper* on a central buffing and drawing apparatus for railway carriages, by E. D. Chattaway, 1856, 173.—Description of coupling, 173.—Defects of ordinary couplings, 173.—Advantages of new coupling, 175.



## BUFFER (continued).

*Discussion.*—Chattaway, E. D., 176, 177.—Dunn, T., 176.—Fenton, J., 176, 177.—Harvey, R., 178.—Morrison, R., 177.—Rankine, W. J. M., 177.—Robertson, H., 177.—Tosh, G., 177.

**BUFFER, SAFETY,** *Paper* on Chesshire's safety buffer, by W. Buckle, 1848, Apl., 15.—Object to lessen injurious effects of collisions on railways, 15.—Safety central buffers added to each carriage acting only in collision, 16.—Force of collision transmitted to van at extremity of train by strong centre rod, 16.

*Discussion.*—Buckle, W., 16, 18.—Chesshire, E., 17, 18, 19, 20.—Cowper, E. A., 19.—Crampton, T. R., 20.—Fenton, J., 17.—Fothergill, B., 20.—McConnell, J. E., 17, 18, 19, 20.—Peacock, R., 19.—Ramsbottom, J., 20.—Stephenson, G., 16, 17, 18, 19, 20.—Wright, J., 17, 18.

**BUFFER, STATION,** *Paper* on a station and collision break apparatus, by C. De Bergue, 1848, July, 17.—Uniform resistance to arrest impetus of train would cause severe concussion, 17.—Gradually increasing resistance is required, commencing at a small amount, 18.—Description of buffing apparatus, 18.—Recoil prevented by rack and pinion, with friction drum on pinion shaft, 18.—Pressure of friction belt increases through range of stroke, 19.

*Discussion.*—De Bergue, C., 19.

**BUFFER, STATION,** *Paper* on a station buffer, by C. De Bergue, 1849, Jan., 10.—Construction of buffer, 10.—Resistance to buffer given by friction clip on pulley, 11.—Pressure of spring on friction clip keeps increasing through stroke of buffer, 11.—Regulation of pressure, 11.—Advantage in small space occupied, and absence of recoil, 11.

*Discussion.*—Adams, W. A., 12.—De Bergue, C., 11, 12, 13, 14.—Fothergill, B., 12.—Hodge, P. R., 14.—McConnell, J. E., 11, 12, 13.—Peacock, R., 13.

**BULLOCK, T., Jun.,** elected Member, 1872, 254.

**BUNNING, T. W.,** elected Member, 1856, 79.

Pile Driver, rate of driving piles with improved steam pile-driver, 1856, 291.—Weight of machine, and of hammer, 291.

**BURGH, N. P.,** elected Member, 1870, 228.

**BURLINSON, W. D.,** elected Member, 1858, 79.—Decease, 1862, 3.—Memoir, 14.

**BURN, D.,** elected Member, 1848, July, 19.

Ventilation of Colliery. *Paper* on the system of ventilation in the Wallsend Colliery, 1849, July, 31.

**BURN, H.,** elected Member, 1858, 12.

**BURROWS, J.,** elected Member, 1871, 262.

**BURY, W.,** elected Member, 1870, 125.

**BURY, W. T.,** elected Member, 1873, 87.



- BUTTERFILL, H. H., elected Member, 1873, 87.  
 BUTLER, A., elected Member, 1863, 113.  
 BUTLER, A. E., elected Member, 1856, 79.  
 BUTLER, G., elected Member, 1859, 97.  
 BUTLER, J., elected Graduate, 1866, 104.  
 BUTLER, J. C., elected Member, 1848, Apl., 23.  
 BUTLER, J. O., elected Member, 1859, 53.  
 BUTLER, T. S., elected Graduate, 1866, 104.  
 BUTLER, W., elected Honorary Member, 1863, 114.

## C.

- CABLES, SUBMARINE TELEGRAPH. *See* Telegraph Cables, 1862, 211.  
 CARRY, C., elected Member, 1871, 262.  
 CARRY, J., elected Member, 1857, 55.  
 CARRY, T., elected Member, 1847.—Council, 1849, Jan., 9.  
 CAIRD, J., elected Member, 1847.  
 CAMBRIAN ENGINE. *See* Locomotive, 1848, Oct., 13.  
 CAMELL, C., elected Member, 1847.  
 CAMPBELL, DANIEL, elected Member, 1867, 18.  
 CAMPBELL, DAVID, elected Member, 1864, 19.  
 CAMPBELL, JAMES (Staveley), elected Member, 1864, 121.  
 CAMPBELL, JAMES (Leeds), elected Member, 1869, 119.  
 CANAL LIFT, *Paper* on a new equilibrium canal lift, for transferring boats from one level to another, without loss of water or of power, by A. Slate, 1851, Oct., 17.—Description of proposed lift, 18.—Mode of action, 19.—Objections to locks, 21.  
*Discussion.*—Mabson, 23.—Slate, A., 22, 23.  
 CANNEL, F. J., elected Member, 1860, 89.—Decease, 1872, 2.—Memoir, 16.  
 Safety Valve, success of Naylor's valve for boilers heated by furnaces, 1865, 231.  
 CARBUTT, E. H., elected Member, 1860, 250.  
 Compressed-Air Hammer, not suitable for steel tilting, 1865, 98.—High-speed steam-hammers, 98.  
 Friction Coupling, testing durability of discs under wear, 1868, 236.  
 CARLTON, S., elected Member, 1865, 101.  
 CARPET-WEAVING, *Paper* on the machinery for weaving Brussels carpet by power, by W. Weild, 1868, 195.—Nature of carpet fabric, 195.—Tapestry, Brussels, and velvet-pile carpets, 196.—Machinery for working the wires, 198.—Fast-wire system, 199.—Roller wire-motion, 200.—Rate of weaving, 206.  
*Discussion.*—Fairbairn, W., 208.—Richardson, W., 207.—Siemens, C. W. 206.—Weild, W., 206, 207, 208.

CARPMAEL, F., elected Member, 1869, 77.

CARPMAEL, W., elected Member, 1862, 47.—Decease, 1868, 2.—Memoir, 14.

CARPMAEL, W., Jun., elected Member, 1866, 103.

CARR, T., elected Member, 1872, 26.

Disintegrator, *Paper* on the disintegrating flour mill, and machine for pulverising minerals &c., without grinding, crushing, or stamping, 1872, 28.—Diminution of number and length of beaters, 37.—Pulverising potsherds, 39.—Pulverising zinc ore, 39.—Disintegrator used in France, 46.—Mills with shorter beaters, 48.—Quantity of flour produced, 49.—Heat not enough to injure flour, 50.—Fermentation due to moisture, not to heat, 50.

CARRETT, W. E., elected Member, 1856, 6.—Council, 1859, 13.

CARRIAGES, RAILWAY. *See* Railway Carriages, 1857, 149.

CARRINGTON, T., Jun., elected Member, 1868, 43.

CARRINGTON, W. T., elected Member, 1864, 19.

CARSON, J. I., elected Member, 1858, 79.

CARTRIDGE MACHINERY, *Paper* on the machinery for the manufacture of the Boxer cartridges, by T. Greenwood, 1868, 105.—Introduction of breech-loading rifles, 105.—Defects of needle-gun, 106.—Rim-fire cartridges, 107.—Central-fire cartridges, 107.—Machines for making Mitford bullets, 108.—Wood-plug machine, 111.—Clay-plug machine, 112.—Cartridge-case machines, 115.—Machines for fixing cartridge together, 123.—Filling and capping, 125.

*Discussion*.—Bouch, W., 130, 133.—Chapman, H., 131.—Davidson, J., 129.—Greenwood, T., 127, 128, 129, 130, 131, 132, 133, 134.—Newton, W. E., 127, 133.—Whitworth, J., 129, 131, 132, 134.

CARTWRIGHT, J., elected Member, 1865, 218.

CARVER, J., elected Member, 1870, 228.

CASPERSEN, H. W., elected Member, 1869, 119.

CAST-IRON BOILER. *See* Boiler, Cast-Iron, 1864, 61.—1871, 263.

CAST-IRON TUBBING. *See* Tubbing, Cast-Iron, 1861, 193.

CAST STEEL, Uchatius. *See* Steel, 1858, 146.

CASTING. *See* Moulding, 1858, 14.

CASTING MOULDS. *See* Moulds, 1854, 62.

CENTRIFUGAL PUMP. *See* Pump, 1852, 99, 153.—1853, 165.

CHADWICK, E., Ventilation of Buildings, suction system correct, 1867, 72.—

Duvoir's system of ventilation, 73.—Cost of ventilating, 73.

CHADWICK, J., elected Member, 1869, 276.

CHADWICK, W., elected Associate, 1866, 18.—Decease, 1871, 2.—Memoir, 15.

CHADWICK AND FROST'S WATER METER. *See* Water Meter, 1857, 175.

CHAIRS, RAILWAY. *See* Railway Chairs, 1849, Jan., 21.—1851, July, 42.—1853, 9.—1873, 252.

CHAMBERLAIN, H., elected Member, 1849, Oct., 32.

CHAMBERLAIN, W., elected Member, 1871, 117.

CHAMBERS, A., elected Member, 1860, 13.

CHANCE, J. T., Regenerative Gas Furnace, very successful for glass-melting furnaces, 1862, 36.—Absence of smoke, 44.

CHAPLIN, A., elected Member, 1856, 250.

CHAPMAN, H. (London), Original Member, 1847.

CHAPMAN, H. (Paris), elected Member, 1866, 103.

Steam Road Roller, light roller used in Paris, followed by a heavier one, 1870, 175.—Steepest gradient rolled, 176.

CHARCOAL MANUFACTURE. *See* Coking, 1857, 25.

CHATELIER STEAM BREAK. *See* Counter-pressure Steam Break, 1870, 21.

CHATTAWAY, E. D., Buffer, *Paper* on a central buffing and drawing apparatus for railway carriages 1856, 173.

CHATWIN, T., elected Member, 1872, 254.

CHATWOOD, S., elected Member, 1867, 59.

CHECKLEY, T., elected Member, 1869, 119.

CHEESMAN, W. T., elected Member, 1873, 87.

CHELLINGWORTH, T. T., elected Member, 1852, 41.

Steam Engine, Expansive, *Paper* on a direct-acting expansive steam engine, 1858, 296.—Consumption of coal, 298.

Steam Engine, Portable, *Paper* on Cox and Wilson's portable single-acting steam engine, 1853, 69.—Cost, 72.—Speed of working, and work done, 72.

CHEMICAL FURNACE, REVOLVING. *See* Furnace, 1869, 229.

CHRIMES, R., elected Member, 1857, 201.

Water Meter, accuracy of Siemens' meter under great variation of pressure, 1856, 122.

CHRONOMETRIC GOVERNOR. *See* Governor, Chronometric, 1853, 75.—1866, 19.

CLAPHAM, R. C., elected Member, 1869, 119.

Furnace, Revolving Chemical, *Paper* on a revolving furnace for chemical works, 1869, 229.

CLARE, T. D., elected Honorary Member, 1851, July, 45.

CLARIDGE, T., elected Member, 1866, 17.

Cupola, ratio of height of cupola to diameter, 1868, 99.

CLARK, C. F., elected Member, 1871, 262.

CLARK, D. K., elected Member, 1854, 5.—Council, 1863, 14.

Expansion in Locomotives, *Paper* on the expansive working of steam in locomotives, 1852, 60.—Pressure in cylinder greater than boiler, when steam pipe heated in smokebox, 84.—Great condensation in outside-cylinder engines, 87.

Expansion in Locomotives, *Supplementary Paper* on the expansive working of steam in locomotive engines, 1852, 109.

CLARK, D. K. (continued).

Locomotive Engines, *Paper* on the locomotive engines in the 1862 International Exhibition, 1863, 78.—Working of very steep gradients, 109.—Brass tubes universally used in locomotives, 110.

CLARK, G., elected Member, 1859, 13.

CLARK, G., Jun., elected Member, 1867, 234.

CLARK, J., elected Member, 1862, 47.

CLARK, T., elected Member, 1869, 276.

CLARK, W. (London), elected Member, 1867, 59.

CLARK, W. (Alfreton), elected Member, 1869, 77.

CLARKE, J., elected Member, 1865, 101.

CLARKE, W., elected Member, 1869, 77.

CLAY, W., elected Member, 1859, 53.—Council, 1863, 14.—Vice-President, 1865, 19.—1866, 16.—1867, 17.—Council, 1868, 19.—1871, 20.

Crane, hide rope for quick-running cranes more durable than cotton, 1868, 168.

Docks, Floating, water driven out of pontoons by forcing in air, 1867, 108.

Flow of Solids, rolled Bessemer steel when reheated loses its fibrous character, 1867, 148.

Hydraulic Machinery, rotating lift, 1868, 35.—Utilising weight of descending lift, 36.

Iron Works, high-pressure blast necessary in Staffordshire furnaces, 1863, 241.

Plate Glass Manufacture, prevention of uneven surface by packing between iron plates in annealing oven, 1863, 223.

Puddling, Mechanical, graphite lining of furnace, 1867, 168.—Lining of coke and tar, 168.

Surface Condensers, theories of corrosion in boilers with surface condensers, 1863, 163.—Corrosion affected by feed, 164.

Turning Tools, *Paper* on an improved construction of tool for turning metals at increased speed, 1872, 288.—Examples of increased speed of turning by use of improved tool, 290.—Taper pin preferred to set-screw for fixing tool, 291.

Well Boring, boring tool for sandstone rock, 1867, 187.

CLAY CROSS COLLIERY, Pumping Engine. *See* Pumping Engine, 1863, 248.

CLAYE, S. J., elected Member, 1860, 53.

CLAYTON, N., elected Member, 1870, 125.

CLAYTON, R., elected Member, 1863, 246.

CLEMINSON, J., elected Member, 1871, 262.

CLENCH, F., elected Member, 1873, 45.

CLERK, F. N., elected Member, 1869, 119.

CLEVELAND BLAST FURNACES. *See* Blast Furnaces, 1864, 249.

CLEVELAND BLAST-FURNACE Materials. *See* Blast-Furnace Materials, 1871, 147.

CLEWORTH, C., elected Member, 1866, 55.

CLIFF, J., elected Member, 1867, 234.

CLIFT, J. E., Original Member, 1847.—Council, 1850, Jan., 5.—1853, 8.—1856, 6.

Brick-Making Machine, *Paper* on Oates' brick-making machine, 1859, 249.

—Rate of production of bricks, 255.—Dry-clay bricks not burnt so thoroughly as wet-clay, 257.

Coking, closed retorts better than open fires, 1860, 194.—Variation in distilled products from different coals, 195.

Creosoting Timber, *Paper* on the preservation of timber by creosoting, 1851, Oct., 10.

Gas Lighting for Trains, water gas-holder objectionable, 1857, 253.

Gas Meter, improved meter very small variation in registration, 1860, 19.—Meters containing machinery very objectionable, 20.—Error in measurement of ordinary meters, 21.

Gas Retorts, *Paper* on improved fire-brick gas retorts, 1852, 178.—Carbon deposit in cracks, 184.—Advantages of double retorts, 185.

India-rubber Pipe Joints, difficulty of repairing joints in angular positions, 1848, Oct., 22.

Pressure Gauge, *Paper* on an improved pressure gauge for steam and water, (Webster's,) 1855, 129.

Ventilation of Colliery, illuminating power of waste gas increased by passing through sponge saturated with naphtha, 1849, July, 38.—Steam jets for emptying gas-holders, 38.

CLUNES, T., elected Member, 1860, 89.

CLYDE STEAM DREDGERS. *See* Dredgers, 1864, 147.

COAL, Combustion, long time required to complete, 1873, 180.

COAL, Consumption of, Air engine, 1873, 74, 81.—Cornish engines, 179.—Marine engines, very low, 80, 179.—Portable engines, 175.—Theoretical minimum, 84.

COAL-CUTTING MACHINE, *Paper* on a coal-cutting machine, by T. Levick, 1864, 272.—Increase of temperature at great depths, 273.—Early coal-cutting machines, 273.—Description of Jones' pick machine, 276.—Speed of working, 278.—Air-compressing engine, 279.—Effect of the air on ventilation, 281.—Advantages of machine, 282.

*Discussion.*—Addenbrooke, G., 290, 291, 293.—Bailey, S., 288.—Cochrane, C., 284, 285.—Cowper, E. A., 283, 287, 292, 296, 297.—Fernie, J., 290.—Haden, W., 285.—Hetherington, J. M., 293.—Hill, T., 293.—Jones, J. G., 289, 292.—Levick, F., 283, 284, 286, 287, 291, 293, 296, 297.—Levick, T., 288, 289, 290, 291, 295.—Lloyd, Sampson, 284, 296.—Mathews, W., 283, 286.—Smith, F., 286, 289, 292, 295, 297.—Swindell, J. E., 289, 290, 292.



**COAL-CUTTING MACHINE**, *Paper* on the application of machinery to coal-cutting, by J. Fernie, 1868, 135.—Objects of machine cutting, 135.—Description of Firth's pick machine, 136.—Particulars of working, 137.—Description of Donisthorpe's slotting machine, 138.—Mode of steadying machine, 141.—Particulars of working, 141.—Air-compressing machinery, 143.—Advantages of machine cutting, 143.

*Discussion*.—Amos, C. E., 151.—Fairbairn, W., 145, 147, 150.—Ferne, J., 145, 147, 150, 155, 160.—Firth, S., 151, 153, 158, 161.—Firth, W., 147, 151, 155.—Gilroy, G., 154, 159.—Hawksley, T., 161.—Lawrence, H., 159., Marshall, W. E., 157, 160.—Menelaus, W., 148, 150, 152, 156.—Moor, W., 157.—Naylor, W., 146.—Warburton, J., 153.—Whitworth, J., 150, 162.—Williams, E., 157.

**COAL-CUTTING MACHINE**, *Paper* on a coal-cutting machine with rotary cutter, worked by compressed air, by R. Winstanley, 1872, 211.—Advantages of machine cutting, 211.—Description of Winstanley and Barker's machine, 212.—Working of machine, 213.—Rate of holing, 214.—Particulars of working of machine, 215.

*Discussion*.—Bramwell, F. J., 220, 221.—Cochrane, C., 217.—Fidler, E., 216, 217, 219, 223.—Lawrence, H., 218.—Menelaus, W., 221.—Ommanney, F. F., 220.—Siemens, C. W., 220, 223.—Winstanley, R., 219.

**COAL MINING**, South Yorkshire, *Paper* on the coal and iron mining of South Yorkshire, by P. Jeffcock, 1862, 68.—General extent of coalfield, 68.—List of principal seams of coal, 69.—Ironstone seams, 71.—Modes of working coal, 72.—Narrow work, 73.—Long work, 74.—Bords and long work, 75.—Wide work, 75.—Bank work, 76.—Long wall, 76.—Water and gas, 77.—Safety lamps, 78.

*Discussion*.—Beale, W. P., 85.—Cochrane, A. B., 80, 82, 83, 84, 86, 87.—Jeffcock, P., 80, 81, 82, 83, 84, 85, 86.—Mathews, W., 81, 82, 84.—Murphy, J., 85.—Swindell, J. E., 81, 82, 84.

**COAL SEAMS IN GLASGOW** Coalfield. *See* Coalfield, Glasgow, 1864, 229.

**COAL**, SOUTH STAFFORDSHIRE THICK, *Paper* on the ten-yard coal of South Staffordshire and the mode of working, by W. Mathews, 1860, 91.—Geological character and extent of coalfield, 91.—Uncertainty as to eastern limit of coalfield, 92.—Position of Thick coal, 93.—Mineralogical peculiarities of Thick coal, 94.—Old description of coalfield, 95.—Modes of working Thick coal, and methods of ventilation, 98.—Waste of coal by "rib and pillar" working, 106.—"Long wall" working, 107.—Area of Thick coal unworked, and probable duration, 109.—Tables of sections of Thick coal at various places, 111.—Table of deaths by accidents in collieries, 115.

*Discussion*.—Cochrane, A. B., 116.—Fenton, J., 120.—Mathews, W., 116, 119, 120.—Swindell, J. E., 119.—Taylor, J., 117.



COALFIELD, GLASGOW, *Paper* on the principal seams of coal and ironstone in the Glasgow coalfield, by W. Moore, 1864, 229.—General description of coalfield, 229.—Table of seams, 230.—Detailed description of coal seams, 231.—Detailed description of ironstone seams, 234.—Fitting and working of collieries, 236.—Railway and canal accommodation, 241.—Consumption of blast furnaces, 243.

*Discussion.*—Adamson, D., 247.—Beale, W. P., 246.—Cowper, E. A., 244.—Manning, J., 246.—Moore, R., 244, 245, 247.—Moore, W., 244, 246, 247.—Napier, R., 245, 247, 248.—Robson, N., 243, 246.

COATES, V., elected Member, 1865, 101.

COCHRANE, A. B., elected Member, 1847.—Council, 1856, 6.—1859, 13.—Vice-President, 1861, 13.—1862, 19.—1863, 14.—Decease, 1864, 2.—Memoir, 13.

Coal, South Staffordshire Thick, yield of coal per acre, 1860, 116.—“Long-wall” working safer for men than “rib and pillar,” 117.

Coke Ovens, *Paper* on a new mode of coking in ovens, (Eaton’s,) applied to the Staffordshire slack, 1861, 72.—Hitherto impossible to coke Staffordshire slack, 89.—Increased density of coke from new ovens, 90.—Staffordshire slack coke very pure and valuable in blast furnace, 91.

Pneumatic Lift, entirely satisfactory and free from accident, 1849, July, 19.

Tubbing, Cast-Iron, durability of pitch coating for cast-iron pipes, 1861, 206.

COCHRANE, C., elected Member, 1858, 266.—Council, 1864, 18.—1867, 17.—1870, 18.—Vice-President, 1872, 25.—1873, 24.

Blast Furnaces, *Paper* on the working and capacity of blast furnaces, 1864, 163.—Effect of distributing cone, 172.—Size of charging valve, 175.—Temperature of blast, 176.—No difference in yield from closing top of furnace, 180.—High temperature of blast increases purity and strength of iron, 182.—Volume of blast in Cleveland furnaces, 256.—Length of time charge remains in furnace, 260.—Precautions against explosions of gas, 262.

Blast-Furnace Gas, *Paper* on a method of taking off the waste gases from blast furnaces, 1860, 121.—Close-topped furnace gives as good iron as open-topped, 267.—Importance of safety valves on gas main in case of explosions, 274.

Blast-Furnace Gas, *Paper* on the further utilisation of the waste gas from blast furnaces, and the economy of coke due to increased capacity of furnace, 1869, 21.—Temperature of gas independent of rate of driving, 38.—Larger furnaces probably lower consumption of coke, 39.—Not possible to absorb all heat from escaping gas, 70.

Blast-Furnace Materials, proposal to reduce ore before its introduction into furnace, 1871, 167.—Falling off in quality of gas when using raw ore, 171.

Boiler, Cast-Iron, metal not injured by fire in Miller boiler, 1871, 273.

COCHRANE, C. (continued).

Boilers, *Paper* on steam boilers with small water space, and Root's tube boiler, 1871, 229.—Desirable to use only distilled water for boilers, 249.

Coal-Cutting Machine, difficulty of applying machine to Staffordshire Thick Coal, 1864, 284.

Cupola, consumption of coke in Ireland's cupola, 1856, 57.

Hot-Blast Stoves, *Paper* on the further economy of fuel in blast furnaces, derivable from the high temperature of blast obtained with Cowper's improved regenerative stoves at Ormesby, and from increased capacity of furnace, &c., 1870, 62.—Temperature of blast can be raised beyond usual working on emergencies, 88.—Fluctuation in temperature of blast from regenerative stoves, not injurious, 89.—Actual and theoretical saving of coke from increased temperature of blast, 90.—Improved regenerative stoves, 91.—Further confirmation of economy from hotter blast, 102.—Best to admit all the air for combustion at once, 102.—High temperature reached in regenerative stoves, 103.—Failure of cast-iron plates in stoves for cooling the escaping gas, 103.—Only small expense for renewal of regenerative stoves, 104.—Limit to economy from increased height of furnace, 104.—Quality of iron improved by hotter blast, 107.

Iron Manufacture, Hæmatite, high blast-furnace unsatisfactory in hæmatite district, 1871, 135.

Tin Stream Works, dressing machine for ironstone in Maryland, 1873, 165.

Tubbing, Cast-Iron, mode of protecting cast-iron pipes from corrosion, 1861, 205.

COCHRANE, H., elected Member, 1860, 250.

COCHRANE, J., elected Member, 1854, 79.

Drilling Machine, *Paper* on a machine for drilling instead of punching wrought-iron plates, 1860, 201.—Great accuracy of drilled holes, 205.—Durability of drills, 206.—Cost of Jacquard punching machine, 207.—Time spent in fixing plate, and drilling, 209.

Riveted Joints, experiments on relative strength of drilled and punched plates, 1872, 79.—Tables of experiments, 80.—No advantage in drilling over careful punching for single plates, 81.—Where several plates to be riveted together, drilled holes better than punched, 81.

COCHRANE, J. B., elected Member, 1869, 77.

COCHRANE, W., elected Member, 1868, 103.

Boilers, failure of Harrison cast-iron boiler, 1871, 245.

Break Drums, failure of cast-iron break blocks rubbing against wrought-iron strap, 1871, 207.

Ventilating Fan, concentric form of case correct, not spiral form, 1871, 30.—Expanding chimney very valuable, 30.—No great variation in water gauge, whether the orifice faces air current or not, 32.

COCHRANE, W. (continued).

Ventilation of Mines, *Paper* on the various systems of ventilation of mines, 1869, 133.—Proportion of power utilised in Guibal fan, 151.—Power required increases as cube of velocity, 153.

COCKER, J., Decimal Measurement, description of Cocker's decimal gauge, 1859, 124.—Cost of gauges, 125.

COCKEY, F. C., elected Member, 1867, 59.

CODDINGTON, W., elected Member, 1864, 59.

COKE, R. G., elected Member, 1847.

COKE, W. L., elected Member, 1867, 59.

COKE OVENS, *Paper* on a new mode of coking in ovens, (Eaton's,) applied to the Staffordshire slack, by A. B. Cochrane, 1861, 72.—Ordinary plan of coking, arrangement of ovens, 72.—Waste of coke by ordinary plan, 74.—Improved plan of coking, circular arrangement of ovens, 75.—Charging, 76.—Working, 77.—Coking of Staffordshire slack, 78.—Action of air during coking, 80.—Size of ovens, 82.—Cost of block of ovens, 83.—Cost of working, 84.—Experiments on coking, 87.

*Discussion.*—Anderson, J., 93.—Cochrane, A. B., 89, 90, 91.—Cochrane, C., 91, 92.—Cowper, E. A., 90, 91.—Haden, W., 89, 91.—Lloyd, Samuel, 90, 91.—Murphy, J., 91, 92.—Paddon, J., 92.—Solly, N. N., 89, 90.—Swindell, J. E., 91.

COKING, *Paper* on the manufacture of charcoal and coke, by E. Rogers, 1857, 25.—Earliest plan of charcoal burning, 25.—Charcoal burning in long mounds, 27.—Introduction of coal for iron smelting, 28.—Coke heaps, 29.—Lord Dundonald's coke ovens, 30.—Hemispherical ovens, 30.—New coking kilns, 31.—Wood unsuitable for iron smelting before being coaled, 33.—Nature of coking process, 34.—Increased yield from hotter ovens, 34.

*Discussion.*—Clift, J. E., 36, 37, 38.—Cochrane, A. B., 40.—Cowper, E. A., 38.—Craig, W. G., 38, 39.—Ramsbottom, J., 37.—Rogers, E., 35, 36, 37, 38, 39, 40.—Whitworth, J., 35, 36, 40.

COKING, *Paper* on a new process of open coking, by S. H. Blackwell, 1860, 188.—Coking bituminous coal in ovens, 188.—Ordinary plan of coking non-caking coal in open fires, 188.—Improved plan of open coking for collecting products of combustion, 190.—Arrangement of pipes and main, 192.—Condensed products of distillation, 192.

*Discussion.*—Blackwell, S. H., 197, 198.—Clift, J. E., 194, 198.—Cochrane, C., 198.—Cowper, E. A., 195.—Kennedy, J., 199.—Mathews, W., 196.

COKING, CRANE, for supplying locomotives. *See* Crane, Coking, 1853, 122.

COLBURN, Z., elected Member, 1854, 59.—Decease, 1871, 2.—Memoir, 15.

## COLBURN, Z. (continued).

Boiler, Cast-Iron, *Paper* on Harrison's cast-iron steam boiler, 1864, 61.—

Convenience for cleaning, 81.—Freedom of cast-iron from corrosion, 81.

Locomotives, Distribution of Weight, use of compensating lever on American railways, 1864, 115.—Great weight below springs in American locomotives, 116.

COLEMAN'S INDIA-RUBBER SPRINGS. *See* Springs, 1853, 45.

COLLIERY, CLAY CROSS, Pumping Engine. *See* Pumping Engine, 1863, 248.

COLLIERY DRAINAGE, Elevator for. *See* Elevator, 1861, 220.

COLLIERY, NEWCASTLE, *Paper* on the improvements and progress in the working and ventilation of coal mines in the Newcastle-on-Tyne district within the last fifty years, by Nicholas Wood, 1858, 177.—Coalfield of Northumberland and Durham, geological position, &c., 178.—Dykes and faults, 182.—Commercial character of coal beds, 185.—Cleveland ironstone, 187.—Extension of coal trade of Northumberland and Durham, 192.—Working of coal, 195.—Coal-cutting machine, 195.—Usual plan of pillar working, 200.—Ventilation of mines, 202.—Description of ventilating furnace, 203.—Arrangement of air-courses, 205.—Lighting of mines, safety lamps, &c., 209.—Sinking pits, drainage, &c., 213.—Railways and steam colliers, 215.—Locomotives, 217.—Steam boats, 219.—Underground conveyance of coal, 220.—Tables of sections of strata, 225 to 233.

*Discussion.*—Armstrong, W. G., 236.—Dunn, M., 234.—Fairbairn, W., 23.—Prideaux, T. S., 233, 235.—Wood, N., 233, 235.

COLLIERY VENTILATION. *See* Ventilation of Colliery, 1849, July, 31.

COLLIERY WORKING, Midland, *Paper* on the mode of working and the mechanical appliances employed in the Midland coalfield, by G. Fowler, 1870, 146.—Modes of working, "pillar" and "long-wall," 146.—Haulage, 148.—Advantages of "endless chain" haulage, 150.—Raising, 152.—Three classes of winding machinery, 152.—Tables giving moments of load and engine power, 154.—Mode of working three classes of engines, 157.—Weights in motion, 158.—Means of obtaining equilibrium of load, 159.—Modification of conical drum to assist engine at starting and stopping, 160.—Four-decked cage, 160.

*Discussion.*—Bouch, W., 163.—Bramwell, F. J., 162, 165.—Fowler, G., 161, 162, 164, 166.—Hawksley, T., 161, 162, 168.—Head, J., 166.—Howe, W., 167.—Hughes, G. D., 166.—Olrick, L., 164.—Paget, A., 164.—Swindell, J. S. E., 168.—Whitehead, P. O., 168.

COLLINGHAM, R. M., elected Graduate, 1873, 251.

COLLINS, J. H., Mining District of Cornwall, *Paper* on the mining district of Cornwall and West Devon, 1873, 89.—Description of minerals of district, 107.—Very small percentage of copper and tin in lodes, 109.—High

COLLINS, J. H. (continued).

temperature of lower levels assists ventilation, 113.—Cornish iron ores hitherto sent away uncleaned, 114.—Origin of “combed” structure in lodes, 114.—Formation of “vughs” or cavities, 115.—Perran iron lode is a true lode, 118.—Cost of cleaning iron ore, 118.

COLVILLE, A., elected Member, 1848.

COMBING MACHINE, *Paper* on the combing of fibrous materials, by B. Fothergill, 1853, 151.—Amount of wool grown in England, 152.—Cartwright’s combing machine, 152.—Heilmann’s improved combing machine, 153.—Sorting of fibres according to length, 154.

*Discussion*.—Dyer, W., 155.—Fairbairn, W., 156.—Fothergill, B., 155.

COMPENSATING APPARATUS for variation in length of signal wires, 1873, 39.

COMPOUND-CYLINDER BLOWING ENGINES. *See* Blowing Engines, 1871, 175.

COMPOUND-CYLINDER ENGINES, *Paper* on the double-cylinder expansive steam engine, by W. Pole, 1862, 242.—Hornblower’s double-cylinder engine, 243.—Woolf’s improvements, 245.—Application of double-cylinder engine to waterworks, 246.—Comparison of single and double-cylinder engines, 248.—Best point of cut-off with different degrees of expansion, 251.—Loss in steam passages, 252.—Analytical investigation of principles of double-cylinder engine, 253.

COMPOUND-CYLINDER MARINE ENGINES. *See* Marine Engines, 1872, 125.

COMPOUND-CYLINDER PUMPING ENGINES, *Paper* on double-cylinder pumping engines, by D. Thomson, 1862, 259.—General arrangement of engines at Lambeth Water Works, 259.—Valves and valve-gear, 260.—Indicator diagrams, 262.—Results deduced from indicator diagrams, 264.—Economy of fuel, 267.

*Discussion*.—Allen, E. E., 276, 287.—Armstrong, Sir W. G., 270, 286, 288.—Cowper, E. A., 277.—Grantham, J., 271.—Hawksley, T., 279, 283, 286.—Pole, W., 268, 283, 284.—Russell, J. S., 275, 284.—Thomson, D., 270, 271, 284, 286.

COMPOUND METALLIC RODS. *See* Metallic Rods, 1855, 18.

COMPRESSED-AIR ENGINE. *See* Air Engine, 1856, 145.

COMPRESSED-AIR HAMMER. *See* Hammer, 1858, 118.—1865, 94.

COMPRESSED-AIR PRESSURE GAUGE. *See* Pressure Gauge, 1859, 179.

COMPRESSED PEAT FUEL. *See* Peat Fuel, 1865, 147.

CONDENSATION OF STEAM, *Paper* on the condensation of steam in the engines of the South Staffordshire iron district, and the improvements to be effected in them, by W. Smith, 1850, Jan., 31.—Particulars of engines, 31.—Character of indicator diagrams, 32.—Importance of making steamways and condenser sufficiently large, 33.—Loss in district from wasteful action of engines, 35.—Table of engine cylinders, 35.

*Discussion*.—McConnell, J. E., 37.—Slate, A., 37.



**CONDENSATION OF STEAM, *Supplementary Paper*** on the condensation of steam in the engines of the South Staffordshire iron district, and the improvements to be effected in them, by W. Smith, 1850, July, 4.—Importance of sufficient size in steam and eduction valves, &c., 5.—Results of increase in valves, &c., 6.—Injection pipe for condenser, 6.—Lime deposit in condenser, 7.—Expansive action, 9.—Saving of fuel in Staffordshire district by improvement of engines, 10.

*Discussion.*—Bowman, R., 11, 12, 13.—Cowper, E. A., 12, 13, 15.—McConnell, J. E., 11, 15, 16.—Slate, A., 12, 15.—Smith, W., 11, 12.—Thornycroft, T., 12.

**CONDENSER.** *See* Boiler and Condenser, 1848, Apl., 5, June, 11.—High-Pressure, 1861, 94.

**CONDENSER, EJECTOR, *Paper*** on the ejector condenser for steam engines, dispensing with an air pump, by A. Morton, 1872, 256.—Principle of action, 256.—Description of condenser, 257.—Condenser raising its own injection water, 258.—Temporary jet of boiler steam to start condenser, 258.—Self-acting piston-valve for jet of boiler steam, 259.—Condenser for pair of engines, 259.—Proportions of jet, 260.—Experiments on condenser, 261.—Indicator diagrams from engines with ejector condenser, 262.

*Discussion.*—Bramwell, F. J., 265, 268.—Morton, A., 263, 264, 266, 267, 269, 270, 273.—Olrick, L., 266, 269.—Perks, J. H., 265, 266.—Robinson, J., 272, 273.—Siemens, C. W., 264, 269, 270, 271, 273.—Thompson, W., 264, 266, 272.

**CONDENSER, REGENERATIVE.** *See* Regenerative Condenser, 1851, July, 20.

**CONDENSER, SURFACE, *Paper*** on a surface condenser, by J. P. Joule, 1856, 185.—Description of condenser, 185.—Degree of vacuum, 186.—Importance of surface condensation, 187.—Improved construction of condenser, 188.—Separate water pump and air pump, 189.

*Discussion.*—Fairbairn, W., 192, 193.—Harvey, R., 192.—Johnstone, J., 193.—Napier, J. R., 193.—Neilson, W. M., 194.—Thomson, W., 191, 194.—Tosh, G., 193.—Whitworth, J., 194.

**CONDENSER, SURFACE, *Paper*** on surface condensation in marine engines, by E. Humphrys, 1862, 99.—First introduction of surface condensers, 99.—Improved make of surface condensers, 100.—Stand-pipe for liberating air, 101.—Tube plates, 101.—Packing and glands for tubes, 102.—Circulation of condensing water, 103.—Particulars of working, 103.—Cleaning of condensers, 104.

*Discussion.*—Armstrong, Sir W. G., 106, 110, 111, 114, 116, 120, 122, 123.—Bovill, G. H., 117, 121, 122.—Bramwell, F. J., 109, 113.—Cowper, E. A., 115, 116, 118, 120.—Everitt, G. A., 112, 113.—Hawksley, T., 111, 113, 119, 120, 122.—Humphrys, E., 105, 106, 110, 111, 112, 113, 114, 118, 121, 122, 123.—Richardson, W., 118.—Spencer, J. F., 106, 109, 120, 121, 122.



CONDENSER, SURFACE, *Paper* on the effects of surface condensers on steam boilers, by J. Jack, 1863, 150.—Introduction of surface condensers, 150.—India-rubber packing for ends of tubes, 151.—Removal of scale from old boilers, 152.—Analysis of deposit formed in new boilers, 153.—Pitting, 153.—Difficulty of accounting for corrosive action of distilled water, 154.—Action of distilled water on metals, 155.

*Discussion.*—Clay, W., 163, 165.—Everitt, G. A., 160.—Gray, J. McF., 157.—Harman, H. W., 159.—Kennan, J., 161.—Mackay, J., 163.—Markham, C., 157.—Poole, B., 162.—Ramsbottom, J., 156.—Reynolds, E., 161.—Rigg, A., 162.—Rollo, D., 158, 161, 165.—Smith, I., 159.

CONDENSING ENGINE, *Paper* on the importance of making a compensation for the pull of the air-pump bucket in the condensing steam engine, by G. Heaton, 1850, Apl., 26.—Particulars of engine experimented on, 26.—Weights acting at each end of beam, 28.—Counterbalance for pull of air-pump bucket, 28.—Results of application, 29.

*Discussion.*—Heaton, G., 30.—Stephenson, R., 29.

CONDENSING ENGINE, *Paper* on an improved horizontal condensing steam engine, by W. B. Johnson, 1855, 198.—Description of engine, 199.—Adjustment for wear of guides, 201.—Compound engine, 201.—Indicator diagrams, 201.

*Discussion.*—Johnson, W. B., 202, 203, 204.—Longridge, R. B., 205.—Peacock, R., 205.—Ramsbottom, J., 202, 205.—Siemens, C. W., 202, 203, 204.

CONTI, P., Ships, *Paper* on a new construction of iron ships for war purposes, 1856, 221.

CONVERSAZIONE, Birmingham, 1860, 177.—Dublin, 1865, 164.—Glasgow, 1856, 195.—Leeds, 1859, 194.—London, 1862, 312.—Manchester, 1857, 133.—Newcastle, 1858, 175.

CONVEX-PLATE SPRING. *See* Spring, 1857, 219.

COOKE, C. W., Air Engine, Heated, *Paper* on Wenham's heated-air engine, 1873, 63.

COOPER, L., Hydraulic Machines, arrangement of pumps and machinery with self-acting regulators, but without accumulators, 1872, 208.

COOPER, S. T., elected Member, 1853, 75.—Decease, 1872, 2.—Memoir, 16.

COPE, J., elected Member, 1860, 250.—Decease, 1871, 2.—Memoir, 16.

COPYING MACHINERY, *Paper* on some applications of the copying or transfer principle in the production of wooden articles, by J. Anderson, 1858, 237.—General extension of copying principle, 237.—Simple copying lathe, 239.—Turning long poles, 239.—Turning wood sabots for round shells, 240.—Turning wood plugs for minié bullets, 241.—Blanchard lathe, 243.—Shaping scabbard linings, 244.—Gunstock manufacture, 245.—Adjusting drills to allow for wear, 247.

## COPYING MACHINERY (continued).

*Discussion.*—Anderson, J., 247, 248.—Armstrong, W. G., 248.—Fairbairn, W., 247.—Fothergill, B., 247.

CORDON, J., elected Associate, 1868, 212.

CORLETT, H. L., elected Member, 1865, 53.

CORLISS EXPANSION VALVE-GEAR. *See* Valve-Gear, 1868, 177.

CORN MILL, BUCHHOLZ, *Paper* on the Buchholz process of decorticating grain, and making semolina and flour by means of fluted metal rollers, by W. P. Baker, 1872, 225.—Structure of wheat grain, 225.—Object of Buchholz process, 226.—Hulling machine, 227.—Self-sharpening of blades, 228.—Semolina mill, 231.—Superiority of Buchholz process, 232.—Subsequent treatment of semolina and bran, 233.—Centrifugal sorter, 233.—Superior quality of flour produced by Buchholz process, 234.

*Discussion.*—Allin, S. S., 236, 238.—Bramwell, F. J., 236, 238.—Mallet, R., 238.—Newton, W. E., 235, 239.—Siemens, C. W., 238, 239.

CORN MILL, FLOATING, *Paper* on a floating steam corn-mill and bakery, by W. Fairbairn, 1858, 155.—Necessity of fresh flour and bread for English army in Crimea, 155.—Description of floating corn-mill, 156.—Amount of flour produced, 156.—Working expenses, 157.—Grinding wheat while vessel in motion, 158.

*Discussion.*—Anderson, J., 159.—Cowper, E. A., 158.—Fairbairn, W., 158, 159.—Smith, W., 159.—Whitworth, J., 159.

CORN-MILL MACHINERY, *Paper* on improved corn-mill machinery, by A. White, 1856, 140.—Injurious effect of centre of stones on wheat, 140.—Annular arrangement of stones, 140.—Distributing disc and fan, 141.—Improved mode of discharging flour from stones, 142.

*Discussion.*—Dunn, T., 142.—Fairbairn, W., 143, 144.—Fothergill, B., 143.—White, A., 142, 143, 144.—Whitworth, J., 143, 144.

CORN-WAREHOUSING MACHINERY, *Paper* on the hydraulic machinery for warehousing grain at the Liverpool docks, by P. G. B. Westmacott, 1869, 208.—Position and arrangement of warehouses, 208.—Importation of breadstuffs, 209.—Employment of hydraulic power, 210.—Experiments with revolving screws for conveying grain, 212.—Conveyance on flat travelling-bands, 214.—Arrangement for transferring grain from band, 215.—Centrifugal spreader, 217.—Hydraulic cranes, 217.—Tubs, weighing hoppers, 218.—General arrangement of bands, 219.—Bucket elevators, 220.—Single and double-acting jiggers, 221.

*Discussion.*—Armstrong, Sir W. G., 228.—Bramwell, F. J., 224.—Carbutt, E. H., 224.—Cowper, E. A., 227.—Ferne, J., 223.—Gilroy, G., 223.—Kennan, J., 227.—Mallet, R., 227.—Olrick, L., 228.—Ramsbottom, J., 222, 224.—Westmacott, P. G. B., 223, 224, 226, 227, 228.

CORNISH PUMPING ENGINES. *See* Pumping Engines.

CORNISH PUMPING ENGINES, Table of Duty for 62 years, 1873, 200.

CORNWALL Summer Meeting, 1873, 87.

CORROSION OF LOCOMOTIVE BOILERS. *See* Boilers, Corrosion of, 1866, 56.

CORRY, E., elected Member, 1848, Apl., 23.

CORTAZZI, F. J., elected Member, 1857, 201.

COTTERILL, E., Lock, description of, 1852, 93.

COTTON-DRAWING ROLLERS, *Paper* on the construction of drawing rollers for spinning machinery, by W. Weild, 1863, 59.—Early inventions for spinning cotton, 59.—Roller gins, 60.—Whitney's saw gin, 62.—Drawing frame, 62.—Ordinary construction of top rollers, 63.—Improved rollers, 64.—Fluting of bottom rollers, 65.—Spiral flutes, 66.—Milling machine for fluting rollers, 67.—Mode of manufacture of rollers, 69.—Action of drawing rollers, 70.—Length of fibre of cotton, 71.—Bessemer steel rollers, 72.

*Discussion.*—Clark, D. K., 77.—Ferne, J., 75, 76, 77.—Joy, D., 75.—Lloyd, Sampson, 72, 73, 74, 75, 77.—Weild, W., 72, 73, 74, 75, 76, 77.

COTTON MILL, Removal of Iron Columns in. *See* Iron Columns, 1866, 181.

COTTON-SPINNING MACHINERY, *Paper* on machinery for the preparing and spinning of cotton, by J. Platt, 1863, 199.—Three distinct operations, 199.—Paul's first spinning machine, 200.—Arkwright's machine, 201.—Hargreaves's spinning jeuny, 202.—Arkwright's further improvements, 205.—Opening, 207.—Scutching, 209.—Carding, 212.—Drawing, 219.—Slubbing, intermediate, and roving, 24.—Houldsworth's differential motion, 223.—Spinning, 227.—Roberts' self-acting mule, 232.—Statistics, 240.

*Discussion.*—Fothergill, B., 241, 244.—Platt, J., 242.—Ramsbottom, J., 244.—Richardson, W., 244.—Whitworth, J., 241, 244.

COTTON SPOOLING, *Paper* on a self-acting machine for spooling thread, by W. Weild, 1861, 54.—Cutting and turning spools, 54.—Hand spooling machines, 55.—Description of self-acting machine, 56.—Traversing the thread guides, 57.—Fastening-off end of thread, 59.—Changing the spools, 59.—Driving pulleys, 60.—Diagrams of cam motions, 61.—Standard for sizes of spools, 64.—Speed of working, 65.

*Discussion.*—Anderson, J., 67, 68, 69.—Bramwell, F. J., 70.—Cochrane, A. B., 67, 71.—Cowper, E. A., 69.—Marshall, W. P., 70.—Weild, W., 66, 67, 69, 70.

COULSON, W., elected Member, 1868, 212.

COULTHARD, H. C., elected Member, 1860, 250.

Iron Works, *Paper* on the new iron works at Grosmont, 1863, 225.

COUNCIL, List of, 1848, Oct., 30.—1849, Jan., 9.—1850, Jan., 4.—1851, Jan., 8.—1852, 1.—1853, 1.—1854, 1.—1855, v.—1856, v.—1857, v.—1858, v.—1859, v.—1860, v.—1861, v.—1862, v.—1863, v.—1864, v.—1865, v.—

## COUNCIL (continued).

1866, v.—1867, v.—1868, v.—1869, v.—1870, v.—1871, v.—1872, v.—1873, v.

COUNCIL, Report of, Annual, 1849, Jan., 3.—1850, Jan., 38.—1851, Jan., 3.—1852, 3.—1853, 3.—1854, 1.—1855, 1.—1856, 1.—1857, 1.—1858, 1.—1859, 1.—1860, 1.—1861, 1.—1862, 2.—1863, 1.—1864, 1.—1865, 1.—1866, 1.—1867, 1.—1868, 1.—1869, 1.—1870, 1.—1871, 1.—1872, 1.—1873, 1.

COUNTER. *See* Engine Counter, 1849, Jan., 14.

COUNTER-PRESSURE STEAM BREAK. *See* Break, 1870, 21.

COUPLING, FRICTION. *See* Friction Coupling, 1858, 22.—1868, 214.

COUPLING ROD. *See* Axlebox, 1858, 166.

COUPLING, SAFETY, for Wagons. *See* Railway Safety Wagon Coupling, 1860, 277.

COURTNEY, W., elected Member, 1849, July, 39.

COWANS, J., elected Member, 1864, 271.

COWEN, G. R., elected Member, 1870, 228.

COWIE, D., elected Member, 1860, 250.

COWPER, C., elected Member, 1849, Jan., 9.—Decease, 1861, 2.

Pressure Gauge, *Paper* on Bourdon's metallic barometer, indicator, and other applications of the same principle, 1852, 141.

Railway Chairs, amount of strain produced by expansion of rails, 1853, 107.

COWPER, E. A., Original Member, 1847.—Council, 1848.—1849, Jan., 9.—1851, Jan., 8.—1857.—1860, 13.—Vice-President, 1863, 14.—1864, 18.—Council, 1865, 19.—1868, 19.

Air Engine, Heated, Ericsson's engine not satisfactory, 1873, 79.—Difficulties much increased in large caloric engines, 80.—Very low consumption in some marine steam engines, 80.

Axles, mode of calculating correct shape for axles, 1850, Oct., 9.

Blast Furnaces, results of working of regenerative hot-blast stoves, 1864, 177.—Casting chilled rolls, 186.—Description of pyrometer, 257.—Mode of washing waste gas, 264.—Illustration of lateral support of materials, 1869, 37.

Blast-Furnace Gas, important to have charging bell properly proportioned in closed-top furnaces, 1860, 130.—Make of iron after taking off gas, 269.—Gas conveyed long distances, 271.

Blooming Machine, cinder effectually squeezed out, 1851, June, 13.

Blowing Engine, *Paper* on a set of six blast engines made for the East Indian Iron Company, 1855, 154.—Single blowing engines give more regular blast without flywheel, unless quick working, 160.—Fan not high enough pressure for blast furnaces, 161.—Pressure of fan blast, 162.

Boiler and Condenser, power required to drive condenser, 1848, Apl., 7.—Comparative surface in atmospheric condenser, 8.

COWPER, E. A. (continued).

- Boilers, importance of having sufficiently large water spaces, 1859, 229.—  
 Loss of heat into brickwork in all externally-fired boilers, 1871, 59.—  
 More frequent blowing-off requisite with sulphate of lime than carbonate of lime, 60.
- Brick-Making, price of cheap hand-made bricks, 1859, 50.
- Coal-Cutting Machine, jet of air and water to clear out groove in coal, 1864, 292.
- Coalfield, Glasgow, construction and working of coal-cutting machine, 1864, 244.
- Condensation of Steam, injection jet from pump, 1850, July, 13.—Improved form of injection valve, 14.—Improved form of air pump, 14.—Indicator figures with improved injection valve, 14.
- Copper Sheathing for Ships, much less durable than formerly, 1867, 57.
- Cupola, very low consumption in Krigar's cupola, 1868, 95.
- Disintegrator, no difficulty in keeping bearings cool, 1872, 43.—Machine when clogged is cleared by reversing for short time, 44.—Mineral disintegrator works well with tough iron ore, 44.—Square beaters possibly better than round, 44.—Less churning of air with closed external casing, 47.
- Double-Cylinder Engines, annular piston objectionable, 1862, 277.—Double-cylinder engines with cranks at right angles, 277.
- Dovetailing Machine, importance of properly spacing dovetails, 1868, 86.—  
 Rapidity of changing saw-blades, 87.
- Expansion in Locomotives, experiment showing that steam is not condensed during expansion, 1852, 85.—Condensation in cylinder due to loss of heat by radiation, 86.
- File-Cutting Machine, Bernot's machine great improvement on former machines, 1859, 143.—Second cut should be lighter than first, 143.
- Governor, Chronometric, experiments on quickness of action, 1866, 34.—  
 Facility of adjusting speed of engine, 42.
- High-Pressure Steam Engine, importance of surface condensation, 1861, 103.—Vertical tubular boilers very liable to priming, 108.
- Hot-Blast Stoves, saving of coke by every rise in temperature of blast, 1870, 87.—Improved arrangement of bricks in stoves, 91.—Cleaning stove by steam jet, 92.—Cost of regenerative stoves, 94.—Quality of iron improved by hotter blast, 108.
- Hydraulic Machinery, comparison with compressed air, 1868, 33.—  
 Differential accumulator, 34.—Early application of accumulator, 34.
- India-Rubber Pipe Joints, *Paper* on Brockedon's application of vulcanised india-rubber to pipe joints (extracts from Wicksteed's report), 1848, Oct., 20.



COWPER, E. A. (continued).

Injector, very low duty when merely raising water not required to be heated, 1860, 80.

Iron, elasticity of iron bar after considerable permanent extension, 1850, Apl., 12.—Nature of fibrous and crystalline iron, 1850, Jan., 16.

Iron Armour for Ships, mode of fastening plates by large screws at edges, 1862, 305.

Locomotive, *Paper* on Cugnot's original invention of the locomotive steam engine for common roads, 1853, 33.

Locomotive Boiler, tendency to prime if all steam had to pass through two openings into steam chamber, 1849, July, 8.

Mining Machinery, experiments on useful effects of blowing fan, 1859, 39.

Nasmyth's Girders, box-girder in form of arch tied by tension bars better than parallel box-girder, 1849, Oct., 32.

Pneumatic Lift, steam might be used for lift where blowing engine not at work, 1849, July, 20.

Polished Sheet Glass, improved construction of furnace to prevent dirt falling into glass pots, 1863, 280.

Pump, Horizontal V, no advantage over ordinary pump, 1864, 43.—Air liable to accumulate, 43.

Pump Valves, importance of small height of lift of valve, 1858, 254.—Double-ring metal valve, 254.

Pumping Engines, *Paper* on two pair of horizontal pumping engines, 1858, 46.—Diagram of lift of pump valves, 57.—India-rubber valves very durable, if just free on centre pin, 59.—Conical injection valve for condenser very successful, 59.—Importance of long guides to double-ring valves, 61.

Pumping Engines, double-acting combined bucket and plunger pumps, 1853, 116.—India-rubber flap-valves best, 1867, 250.—Compound engine probably better than present Crossness engines, 251.—Surface condenser much preferable to present injection condenser, 252.

Railway Bridge Piers, importance of sinking cylinders as rapidly as possible, 1863, 29.—Sand-pump for sinking piers in sand, &c., 29.

Railway Carrying Stock, importance of thick edges to flanges of iron sole-bars, 1851, Jan., 17.

Railway Chairs, *Paper* on an improved mode of moulding chairs, 1851, July, 43.—Ransome and May's process, 44.

Railway Springs, friction between plates of ordinary springs prevents proper action, 1858, 163.

Regenerative Gas Furnace, very valuable as reheating furnace, 1862, 44.

Regenerative Hot-Blast Stoves, *Paper* on some regenerative hot-blast stoves working at a temperature of 1300° Fahrenheit, 1860, 54.—Stoves heated by coal fire, 64.—Cost of regenerative stoves, 70.



COWPER, E. A. (continued).

- Rifled-Gun Manufacture, tool for boring Lancaster guns, 1862, 143.
- Rivet-Making Machine, cast iron best for dies for hot iron, 1861, 217.
- Roof, *Paper* on the wrought-iron roof over the central railway station at Birmingham. 1854, 79.—Testing of principals, 83.—Adjustment of strain on rods, 85.—Main ribs, 85.—Expansion by heat, 87.
- Rope Manufacture, strength of hard steel wire, 1862, 208.
- Screwing Machine, large bolts require more than once screwing to get clean thread, 1861, 237.
- Spooling Machine, mode of reversing travel of thread guides after winding each layer, 1861, 69.
- Starting Apparatus, angle at which conical clutches work without sticking, 1848, Apl., 14.—Three expanding segments make best kind of clutch and easily managed, 1849, Jan., 20.
- Steam Crane, probably not more economical than high-pressure water crane, 1859, 177.
- Steam Hammer, cause of steadiness of Morrison's hammer, 1855, 16.—Importance of steam jacket to cylinder, 1860, 289.
- Superheated Steam, effect of superheating in expanding steam, 1859, 203.—Steam condensed at beginning of stroke and evaporated again at end, in cylinder without steam jacket, 204.—Oil not suitable for lubricating cylinders with highly superheated steam, 208.—Lubrication by slight condensation in cylinder, 208.
- Surface Condenser, horizontal tubes not so good as vertical, 1862, 115.—Amount of water-current requisite to remove air-bubbles from sides of tubes, 116.—Pitting of boilers probably due to grease, 117.—Prevention of pitting, 118.—Perkins' condensers, 119.—Boilers not corroded if filled with salt water at first, 120.
- Suspension Bridge, *Paper* on an improved suspension bridge, "Inverted Arch," 1847, Oct., 1.
- Telegraph Machinery, Siemens' cable specially adapted to resist action of marine animals, 1867, 42.
- Tool and Holder, gauge for angle of cutting edges of tools, 1866, 300.
- Ventilating Fan, closing top of shaft, 1869, 95.—Particulars of experiments on blowing fans, 96.—Fan probably as good in results as Lemielle's machine, and less complicated, 1858, 68.—Case should be spiral all round, and vary in pitch, 1871, 71.
- Ventilation of Mines, experiments on blowing fan, 1869, 150.—Spiral casing best, 150.
- Water Works, Glasgow, success of Siemens' rotary meters, 1864, 141.—Purity of Glasgow water, 142.
- Well-Boring, means of recovering broken pump-rod, 1869, 307.

COWPER, E. A. (continued).

Wrought-Iron Lighthouse, importance of diagonal bracing, 1861, 26.—

Diagonal stays should start from foundation. 26.

COWPER'S Regenerative Hot-Blast Stoves. *See* Hot-Blast Stoves, 1870, 62.

COX, S. H. F., elected Member, 1852, 41.—Re-elected, 1862, 47.

COX and Wilson's Steam Engine. *See* Steam Engine, Portable, 1853, 69.

CRADDOCK, T., elected Member, 1848.

Boiler and Condenser, *Paper* on a boiler and condenser suitable for extending the Cornish economy, and for preventing boiler explosions, 1848, Apl., 5.—Vacuum obtained with condenser, 7.—Loss of high-pressure steam from condensing in cylinder, 11.—Advantages of condenser for marine engines, 11.

Boiler and Condenser, *Supplementary Paper* on a boiler and condenser suitable for extending the Cornish economy, and for preventing boiler explosions, 1848, June, 11.

CRAIG, A., elected Member, 1863, 113.

CRAIG, W. G., elected Member, 1853, 8.—Council, 1857, 11.

Axlebox, *Paper* on an improved axlebox and spring fittings for railway carriages, 1855, 182.

Coal-Burning Locomotive, tubes more durable with coal than with coke, 1858, 290.—Firegrate with alternate bars raised above the others. 291.

Feed-Pipe Connexion, durability of new connexion, 1857, 101.—Duration of india-rubber hose pipes, 101.

Fuel Economiser, *Paper* on an apparatus for economising fuel, 1857, 196.

Springs, *Paper* on improved india-rubber springs for railway engines, carriages, &c., 1853, 45.—India-rubber not affected by high temperature, 55.—Pressure on india-rubber springs, 55.—Cost, 56.

CRAMPTON, T. R., elected Member, 1847.

Boiler and Condenser, loss in expansion of steam in travelling from small to large cylinder, 1848, Apl., 9.

Boiler Explosions, corrosion of boiler can be prevented, 1870, 205.—Packing of cylinders, to do without grease, 205.

Boiler, Mechanical Firing, use of coal in form of fine powder, 1869, 176.—Experiments with powdered coal in reverberatory furnace, 177.

Cambrian Engine, objection from varying lengths for connecting-rods, 1848, Oct., 14.

Expansion in Locomotives, working of steam-boat engines, showing loss of power from condensation, 1852, 129.

Marine Engines, very little advantage in high-pressure steam, 1872, 166.—Lower pressures advisable for marine engines, 167.—With lower pressures single-cylinder engines better than compound, 168.—Great advantage of steam-jackets, 173.—Superheating of steam not desirable, 174.

CRANE, COKING, *Paper* on an improved coking crane for supplying locomotive engines, by J. Ramsbottom, 1853, 122.—Description of crane, 122.—Saving in time of loading, and number of attendants, 123.

*Discussion.*—Beyer, C. F., 124.—Cowper, C., 124, 125.—Downing, G., 125.—Gibbons, B., 125.—Lloyd, Sampson, 125.—Ramsbottom, J., 124, 125.—Woodhouse, H., 124.

CRANE, STEAM, *Paper* on a direct-acting steam crane, by R. Morrison, 1859, 168.—Ordinary steam cranes objectionable on board ship, 168.—Description of direct-acting crane, 168.—Piston-packing and stuffing-box, 169.—Mode of working, 169.—Blow-through valve, 171.—Piston of turning-round cylinder, 171.—Modification of arrangement, 172.—Particulars of cost of working, 173.—Greater rapidity of discharging than ordinary steam cranes, 174.

*Discussion.*—Anderson, J., 176.—Bastow, S., 178.—Cowper, E. A., 177, 178.—Leslie, A., 175.—Morrison, R., 175, 176, 177, 178.—Penn, J., 178.

CRANE, STEAM, *Paper* on a steam crane, by J. C. Evans, 1859, 238.—Boiler, 238.—Cylinder and gearing, 239.—Turning gear, 240.—Valve motion, 240.

*Discussion.*—Cowper, E. A., 241.—Evans, J. C., 240, 241, 242.—Maudslay, H., 241, 242.—Penn, J., 242, 243.

CRANE, TRAVELLING, *Paper* on an improved steam travelling crane, by W. Fairbairn, 1854, 96.—General arrangement, 96.—Description of crane, 97.—Adjusting tension of chains, 98.—Rate of working, 98.

*Discussion.*—Cowper, E. A., 99, 100.—Dunn, T., 99, 100.—Fairbairn, W., 99, 100.—Lloyd, Sampson, 100.—McConnell, J. E., 99.

CRANE, TRAVELLING, *Paper* on a travelling crane worked by clip-drum and wire rope, by J. Fernie, 1868, 164.—Description of crane, 165.—Rate of driving of rope, 165.—Lifting gear, 166.—Power required to drive crane, 167.

*Discussion.*—Amos, C. E., 173.—Bramwell, F. J., 174.—Carbutt, E. H., 174.—Chapman, H., 171.—Clay, W., 168.—Cowper, E. A., 168, 170, 171.—Fairbairn, W., 175.—Ferne, J., 168, 171.—Greig, D., 169, 170, 172.—Reynolds, E., 174.—Siemens, C. W., 171.—Walker, B., 172, 174.

CRANE, TRAVERSING, *Paper* on the improved traversing cranes at Crewe Locomotive Works, by J. Ramsbottom, 1864, 44.—Driving cord, 44.—Overhead traversers, 45.—Tightening frame, 45.—Longitudinal driving gear, 46.—Lifting and lowering gear, 47.—Cross traversing gear, 48.—Traversing jib cranes, 49.—Lifting speed, 51.—Driving cords, 52.—Slippers, 53.—Worm wheels, 53.

*Discussion.*—Carbutt, E. H., 58.—Cowper, E. A., 57, 58.—Ferne, J., 55.—Napier, R., 54, 55, 56, 57, 58.—Ramsbottom, J., 54, 55, 56, 57, 58.—Williams, R., 56.

CRANE, TUBULAR, *Paper* on tubular wrought-iron cranes; with description of the sixty-ton tubular wrought-iron crane recently erected at Keyham Dockyard, Devonport, by W. Fairbairn, 1857, 87.—Description of small cranes first erected, 87.—Experiments on deflection of jib under load, 89.—Curved jib enables bulky load to be raised much higher than ordinary straight jib, 91.—Description of sixty-ton crane, 92.—Construction of jib, 93.—Gearing, 95.—Pedestal, 95.

*Discussion*.—Fairbairn, W., 96, 97, 98.—Hawkes, W., 97.—McConnell, J. E., 96.—Rankine, W. J. M., 97, 98.—Whitworth, J., 98.

CRAVEN, J., elected Member, 1871, 262.

CRAVEN, W., elected Member, 1866, 264.

CRAWHALL, J., elected Member, 1858, 79.

CREWE LOCOMOTIVE WORKS, Traversing Cranes. *See* Cranes, Traversing. 1864, 44.

CRIPPIN, E. F., elected Member, 1873, 45.

CRISWICK, T., elected Member, 1857, 55.

CROOME, J., elected Member, 1848.

CROSBY, S., elected Honorary Member, 1848, Apl., 24.

Boiler Tubes, Green's solid-drawn tubes, 1867, 54.—Thickness of locomotive boiler tubes, 55.

CROSLAND, R., elected Member, 1848, Apl., 23.

CROSS, J., elected Member, 1865, 101.

CROSSING, RAILWAY. *See* Axlebox and Crossing, 1852, 213.—Railway Crossing, 1856, 35.

CROSSLEY, J., elected Associate, 1866, 265.

CROSSLEY, L. J., elected Member, 1869, 276.

CROSSLEY, W., elected Member, 1871, 117.

Iron Manufacture, Hæmatite, *Paper* on the manufacture of hæmatite iron, 1871, 118.—Scaffolding in furnace due to small size of ore, 136.—Cause of failure of high hæmatite furnace, 136.—High hæmatite furnaces will probably prove successful, 145.

CROSSNESS PUMPING ENGINES. *See* Pumping Engines, 1867, 236.

CROW, G., elected Member, 1863, 57.

CROWE, E., elected Member, 1864, 59.

CRUSHING MACHINE, *Paper* on Berdan's crushing and amalgamating machine, by W. P. Marshall, 1854, 33.—Occurrence of gold in different countries, 33.—Principles of extraction, 34.—Description of crusher, 36.—Distilling amalgam, 37.—Séparator, 39.—Details of cost of process, 40.

*Discussion*.—Cowper, E. A., 42.—Fairbairn, W., 42.—Marshall, W. P., 41.—Slate, A., 41.—Stansbury, C. F., 41, 42.—Stirling, J. D. M., 42.

CRUSHING MACHINERY for Stone. *See* Stone-Crushing Machinery, 1860, 234.—1864, 20.

- CUBITT, B., Original Member, 1847.
- CUBITT, C., elected Member, 1858, 266.
- CUGNOT'S LOCOMOTIVE. *See* Locomotive, 1853, 33.
- CULTIVATION. *See* Agricultural.
- CUNLIFFE, R., Elevator for Colliery Drainage, work done by elevators of various sizes, 1861, 225.—Elevator at Kippax Colliery, 226.—Height to which elevator will raise water, 229.
- Screwing Machine, sizes of machine, 1861, 235.—Durability of cutters, 235.—Cost of machine, 236.—Rate of working, 236.
- CUPOLA, *Paper* on an improved cupola for iron foundries, by J. Eichhorn, 1868, 89.—Disadvantages of ordinary cupola, 89.—Description of Krigar's cupola, 90.—Filling, 91.—Consumption, 91.—Better metal produced than with ordinary cupola, 92.—Blast, 92.—Repairs, 93.—Loss of metal, 93.
- Discussion.*—Claridge, T., 99.—Cowper, E. A., 95.—Eichhorn, J., 98, 100.—Ferne, J., 96.—Hawksley, T., 98, 99, 100, 101.—Siemens, C. W., 94, 98.—Walker, C. C., 96, 98.—Webb, F. W., 95.
- CUPOLA, Ireland's. *See* Hoist and Cupola, 1856, 49.
- CURTIS, M., elected Member, 1850, Jan., 5.—Re-elected, 1865, 218.
- CURVILINEAR SHAPING Machine. *See* Shaping Machine, 1866, 280.
- CUSS, N. J., elected Graduate, 1867, 60.
- CUTTS, W., elected Member, 1848, Apl., 23.
- CYLINDERS, Boring of. *See* Boring Locomotive Cylinders, 1848, Apl., 3.

## D.

- DAGLISH, G. H., elected Member, 1864, 19.
- Plate Glass Manufacture, *Paper* on machinery for the manufacture of plate glass, 1863, 209.
- DAGLISH, J., elected Member, 1869, 119.
- Steam Boilers, Mechanical Firing, *Paper* on the mechanical firing of steam boilers, 1869, 155.—No advantage from using wheel-flue, 176.
- DAGLISH, R., Jun., elected Member, 1848, July, 19.
- DANIEL, E. F., elected Member, 1866, 103.
- DANIEL, W., elected Member, 1866, 55.
- DANSON, T. J., elected Member, 1872, 254.
- DARBY, A., elected Member, 1865, 53.
- DARBY, C. E., elected Member, 1864, 19.
- DASH-WHEEL, *Paper* on a steam dash-wheel for bleaching, by J. Wallace, Jun., 1856, 239.—Description of dash-wheel, 239.—Rate of rotation, and steam pressure, 240.—Application to bleaching, 240.
- Discussion.*—Fothergill, B., 241.—Russell, J. S., 241.



DAVEY, H., elected Member, 1873, 87.

DAVIDSON, J., elected Member, 1865, 101.

Cartridge Machinery, rate of production of cartridges at Woolwich Arsenal, 1868, 129.

DAVIES, B., elected Member, 1865, 218.

DAVIS, H. W., elected Member, 1868, 43.

DAVIS, J., elected Member, 1848, July, 19.

DAVIS, J. H., elected Member, 1873, 45.

DAVY, A., elected Member, 1863, 246.

DAVY, D., elected Member, 1873, 87.

DAWES, G., elected Member, 1849, Apl., 32.

DAWES, W. H., elected Member, 1860, 53.

DAWSON, B., elected Member, 1861, 53.

DAWSON, C. H., elected Member, 1848, Apl., 23.

DAY, S. J. V., elected Member, 1869, 120.

DEAKIN, W., elected Member, 1862, 20.

DEAN, W., elected Member, 1868, 20.

DEANE, J. H., elected Member, 1857, 201.—Decease, 1862, 3.—Memoir, 14.

DEATH, E., elected Member, 1866, 17.

DE BERGUE, C., elected Member, 1848, Apl., 23.—Re-elected, 1857, 201.

Rivet-Making Machine, *Paper* on a rivet-making machine, 1861, 212.

Springs, india-rubber springs, action of, 1850, Apl., 21.—Effective resistance of india-rubber and laminated springs, 22.—Durability of india-rubber, 23.—Table of compression of india-rubber springs, 24.

Station Buffer, *Paper* on a station buffer, 1849, Jan., 10.—Ordinary spring buffer could not be regulated in resistance, and had recoil to contend with, 12.—Spring buffers much less resisting power, 13.

DECIMAL MEASURE, *Paper* on a standard decimal measure of length for mechanical engineering work, &c., by J. Whitworth, 1857, 134.—Measurement by sight not sufficiently accurate, 135.—Effect of lubrication on well-fitted gauges, 136.—Allowance for oil in fitting machinery, 137. Proving guns by measurement, 138.—Proposed decimal screw and wire gauge, 140.

*Discussion*.—Aston, 147.—Clift, J. E., 147.—Crampton, T. R., 144.—Dodds, I., 148.—Dyer, G., 142, 146.—Fairbairn, W., 142, 147.—Fox, Sir C., 143, 147.—Kennedy, Col., 147.—Maudslay, H., 145.—McConnell, J. E., 143, 144, 147.—Rankine, W. J. M., 147.—Whitworth, J., 142, 145.

*Adjourned Discussion*.—Fairbairn, W., 227, 228, 230.—Fenton, J., 228.—Inshaw, J., 229.—McConnell, J. E., 228, 229.—Ross, J., 229.

Resolution to adopt decimal scale, the inch being divided into one thousand parts, 1857, 148.—Resolution for committee to carry out decimal system of measure, 228.



**DECIMAL MEASURE**, *Paper* on the application of the decimal system of measurement to mechanical engineering work, &c., by J. Fernie, 1859, 110.—Importance of introducing a decimal system of measurement, 110.—Objections to metre as standard, 112.—Means of verifying inch and metre, 113.—Inconvenience from number of different wire-gauges in use, 114.—No difficulty in working to 1-1000th inch, 115.—Measuring machines with sliding wedge or spiral, 115.—Whitworth's measuring machine with screw, 116.—Graduation of hand-wheel, 117.—Importance of having a means of justifying templates, &c., 118.—Use of decimal rules in workshops, 119.

*Discussion*.—Brown, R., 128.—Cocker, J., 124, 125.—Fernie, J., 127, 128.—Markham, C., 129.—Maudslay, H., 128.—Smith, I., 132.—Smith, M., 131.—Whitworth, J., 121, 125, 129, 130, 132.

**DECIMAL MEASURE**, *Paper* on the application of the decimal system of measurement in boring and turning wheels and axles, by J. Fernie, 1860, 223.—Variation amongst gauges for wheel-boss and axle, 223.—Experiments on various degrees of tightness of wheel on axle, 223.—Allowance for shrinkage in cranks, crossheads, &c., 226.—Whitworth's decimal measuring machine, 227.—Graduation of hand-wheel, 227.—Mode of making duplicates of gauges, 228.

*Discussion*.—Barber, J., 231, 233.—Cochrane, J., 233.—Dunn, T., 232.—Fernie, J., 229, 232, 233.—Kennedy, J., 233.—Markham, C., 230.—Siemens, C. W., 230, 231.

**DECIMAL MEASURE**, *Inch and Metre*, *Paper* on the relative advantages of the inch and the metre as the standard unit of decimal measure, by J. Fernie, 1865, 21.—Desirability of decimal system, 21.—Requirements of standard of measure, 22.—Basis of metre, and of inch, 23.—Whitworth's contact measurements, 25.—Advantages of inch for decimal subdivision, 26.—Extent of use of inch and of metre, 29.—Difficulty of changing inch to metre system, 31.—Relation of weights to measures, 32.—General conclusions, 32.

*Discussion*.—Fellows, F. P., 39.—Fernie, J., 34, 50.—Heywood, J., 44.—Levi, L., 48.—Napier, R., 35, 51.—Russell, J. S., 46.—Siemens, C. W., 42.—Yates, J., 35.

DEES, J., elected Member, 1858, 45.

DEMPSEY, W., elected Member, 1858, 45.

DENNY, W., elected Member, 1848, July, 19.

DENT, E. J., elected Member, 1849, Apl., 32.

DENTON, C., elected Member, 1848, Apl., 23.

DENTON, J. P., elected Member, 1872, 75.

DERHAM, J. J., elected Member, 1868, 103.

DEWHURST, J., elected Member, 1864, 59.

DEWHURST, J. B., elected Associate, 1867, 60.

DIRCKS, H., elected Member, 1865, 218.

DIRECT-ACTING Marine Engine. *See* Marine Engine, 1856, 159.

DISINTEGRATOR, *Paper* on the disintegrating flour mill and machine for pulverising minerals &c., without grinding, crushing, or stamping, by T. Carr, 1872, 28.—Principle of action of machine, 28.—Description of disintegrating flour mill, 29.—Diagram of action of disintegrator, 31.—Advantages, 31.—Disintegrators working at Bonnington Mills, 32.—Economy of disintegrator in value of flour produced, 33.—Improved form of machine, 34.—Mineral disintegrator, speed of working, 35.—Cleaning of beaters, 35.—Applications of disintegrator, 36.

*Discussion.*—Bramwell, F. J., 40, 47, 51, 52.—Carbutt, E. H., 39, 51.—Carr, T., 37, 38, 39, 43, 44, 45, 46, 48, 49, 50, 51.—Cowper, E. A., 43, 47, 52.—Greenwood, T., 45, 50.—Lloyd, Sampson, 48.—Paget, A., 46.—Perks, J. H., 40.—Siemens, C. W., 38, 48, 49, 52.—Webb, F. W., 45.

DIXON, E., elected Member, 1851, Oct., 28.

DIXON, J., elected Member, 1859, 13.

DIXON, T., elected Member, 1861, 211.

DOBSON, B., elected Member, 1865, 53.

DOBSON, B. A., elected Member, 1872, 254.

DOBSON, R. J. C., elected Graduate, 1873, 251.

DOCK, Floating, *Paper* on floating docks, and other arrangements for affording access to ships for external repairs, by F. J. Bramwell, 1867, 80.—Careening, 80.—Graving dock, 81.—Belidor's double graving dock, 82.—Hauling up ships out of water; Morton's slips, 83.—Contrivances for shortening slip, 84.—Direct lifts, Mitchell's, 86.—American screw lift, 87.—Mallet's parallel-sling lift, 87.—Clark's hydraulic lift, 88.—Floating docks, 89.—Sectional floating dock, 90.—Balance or box dock, 91.—Floating dock for island of St. Thomas, 95.—Engines and machinery, 99.

*Discussion.*—Bramwell, F. J., 106, 109, 110.—Clay, W., 108.—Mallet, R., 105, 110.—Penn, J., 112.—Siemens, C. W., 108.—Thomson, R. W., 107.

DOCKRAY, R. B., elected Member, 1850, Jan., 5.

DODDS, I., Safety Escape Pipe, deterioration of ordinary lead plugs after long working, 1857, 182.

Steel Manufacture, durability of steeled rails, 1857, 170.

DODDS, T. W., elected Member, 1854, 49.

Steel Manufacture, *Paper* on improvements in steel manufacture, and its application to railway and other purposes, 1857, 162.—Wheel tyres and rails partially converted, 168.—Wrought-iron files converted, 169.

DODMAN, A., elected Member, 1868, 103.

DOMVILLE, C. K., elected Member, 1865, 101.

DONKIN, B., Jun., elected Member, 1873, 250.

DOUBLE-CYLINDER ENGINES. *See* Compound Engines.

DOUGLAS, C. P., elected Member, 1865, 101.

DOUGLAS, G., elected Member, 1857, 11.

DOUGLAS, R., Valve Gear, Corliss gear very durable, 1868, 190.—Very prompt action of governor, 191.

DOVE, G., elected Member, 1857, 55.

DOVE, G., Jun., elected Member, 1873, 45.

DOVETAILING MACHINE, *Paper* on the American dovetailing machine, by J. Robinson, 1868, 81.—Arrangement of saws, 81.—Change from cutting pins to cutting holes, 82.—Saws, 83.—Traversing the wood, 83.—Adjustment for thickness of saw cuts, 84.—Cutting concealed dovetails, 85.—Working speed, 86.

*Discussion.*—Chapman, H., 86.—Cowper, E. A., 86.—Hawksley, T., 86, 87, 88.—Robinson, J., 86, 88.

DOWLAIS IRONWORKS ENGINES, *Paper* on the large blowing engine and new rolling mill at Dowlais Iron Works, by W. Menelaus, 1857, 112.—Blowing engine, cylinders and valves, 112.—Beam, 113.—Rolling mill engines, 113.—Arrangement of rolls for working in both directions, 115.

*Discussion.*—Cochrane, C., 116, 117, 118.—Fairbairn, W., 116, 117, 118.—Jones, E., 115.—Maudslay, H., 116.—McConnell, J. E., 115.—Menelaus, W., 116, 117, 118.

DOWNES, J. C., elected Graduate, 1867, 60.

DOWNEY, A. C., elected Member, 1866, 264.

DOWNIE, J., Foundry, *Paper* on an iron construction of foundry, and an improved process of moulding pipes and hollow cast ware, 1856, 165.—Cost of building, 170.—Swing cranes preferred to travelling cranes, 170.

DOWNING, G., elected Member, 1851, Jan., 8.

DOWNING, S., elected Honorary Life Member, 1865, 219.

Rock-Boring Machine, rate of boring, 1865, 192.—Cost of machine, 193.

DREDGERS, CLYDE, *Paper* on the construction and results of working of the large steam dredgers on the Clyde, by A. Duncan, 1864, 147.—Particulars of enlarging the channel of river, 147.—Double dredgers, 148.—Friction wheels, 151.—Bucket frames, 151.—Process of dredging, 152.—Durability of working parts, 154.—Cost of dredging, 155.—Disposal of spoil, 155.—Large dredger, 156.

*Discussion.*—Birckel, J. J., 161.—Marshall, W. P., 160.—Maudslay, H., 160.—Napier, R., 158, 161.—Newton, W. E., 159.—Shepherd, J., 160.—Simons, W., 157, 158.

DREDGERS, SUEZ CANAL, *Paper* on the steam dredgers employed in the excavation of the Isthmus of Suez Canal, by P. Borel, 1867, 192.—Recent retreat of the Mediterranean and Red Seas, 192.—General nature of ground, 192.—Course of canal, 193.—Dredgers, 194.—Dredgers with

## DREDGERS, SUEZ CANAL (continued).

extra-long shoots, 196.—Elevators for spoil-trucks, 199.—Conveying dredgers to working place, 201.—Excavation of canal through high ground, 202.—Lighters, 203.—Repairs, 205.—Manner of passage of different sorts of spoil down shoots, 205.

*Discussion.*—Beaumont, Capt. F., 215.—Borel, P., 207, 214, 215, 216, 217.—Cochrane, C., 214.—Mallet, R., 216, 217.—Penn, J., 207, 214.—Williams, R. P., 215.

DREDGING LADDER, *Paper* on an improved ladder for dredging machines, by M. Scott, 1856, 217.—Failure of timber ladders, 217.—Description of improved ladder, 218.—Advantages, 219.

*Discussion.*—Fairbairn, W., 220.—Scott, M., 220.—Whitworth, J., 220.

DRILLING MACHINE, *Paper* on a double-traversing drilling and grooving machine, by T. Forsyth, 1856, 108.—Description of machine, 108.—Feed motion, 108.—Drills, 109.—Dimensions of largest machine, 110.

*Discussion.*—Batho, W. F., 112.—Forsyth, T., 111.—Lloyd, Sampson, 111, 112.—Siemens, C. W., 112.

DRILLING MACHINE, *Paper* on a machine for drilling instead of punching wrought-iron plates, by J. Cochrane, 1860, 201.—Description of machine, 201.—Pressure on drills given by accumulator, 202.—Arrangement of shafts and drill spindles, 202.—Spring buffers to relieve pressure when drills are nearly through plate, 203.—Working pressure on each drill; speed of drilling, 204.

*Discussion.*—Cochrane, J., 205, 206, 207, 209, 210.—Cowper, E. A., 208.—Dunn, T., 206.—Ferne, J., 207.—Hurry, H. C., 208.—Kennedy, J., 210.—Little, C., 210.—Markham, C., 206, 209.—Richardson, W., 206, 209.

DRU, L., Well-Boring, *Paper* on the machinery for boring artesian wells, 1867, 174.—Disengaging rod for tools of large diameter, 182.—Unscrewing couplings of broken rod in bore-hole, 183.—Cost of Paris borings, 183.—Rope boring not successful in France, 186.—Boring through running sands, 189.—Tool for inclined hard surface, 190.—Wax impression of broken rod, 191.

DRY-CLAY Brick Machinery. *See* Brick Machinery, 1859, 42.

DUBLIN Summer Meeting, 1865, 101.

Water Works. *See* Water Works, Dublin, 1865, 201.

DÜBS, H., Original Member, 1847.

DUCLOS DE BOUSSOIS, E., elected Member, 1853, 8.

Iron Manufacture, doubtful whether zinc alloys with iron, 1853, 28.

DUDGEON, J., elected Member, 1856, 79.

DUDGEON, W., elected Member, 1856, 79.

DUGARD, W. H., elected Graduate, 1868, 43.

DUNCAN, A., Steam Dredgers, *Paper* on the construction and results of working of the large steam dredgers on the Clyde, 1864, 147.

DUNCAN, T., Water Works, Liverpool, *Paper* on the mechanical features of the Liverpool Water Works, 1863, 167.—Durability of gutta-percha valves, 186.—Bored and turned joints for mains, 186.—Flanged joints no longer used for mains, 188.—Double-cylinder water meter, 190.

DUNLOP, J. M., elected Member, 1857, 232.

DUNLOP, J. W., elected Member, 1870, 19.

DUNN, T., elected Member, 1854, 110.

Boiler, *Paper* on a new duplicate retort steam boiler, 1855, 191.

Boiler, *Paper* on an improved construction of upright steam boilers, 1857, 130.

Crane, length of travel of improved steam travelling crane, 1854, 99.—Cost, 99.—Weight, 99.

DUNN, T. E., elected Member, 1864, 121.

DUTTON, C., elected Member, 1861, 14.

DUTY OF STEAM ENGINES. *See* Engine Duty.

DYNAMITE for blasting in wet ground, 1873, 100.

DYNAMOMETER, *Paper* on a new dynamometer and friction break, by W. Froude, 1858, 92.—Machines to be tested, classified as power-consuming or power-supplying, 92.—Belt dynamometer, principle of action, 93.—Description of belt dynamometer, 94.—Self-recording apparatus, 95.—Particulars of trials, 98.—Friction dynamometer, 100.—Experiments on friction of belts on drums of small and large diameter, 102.—Friction of belts on drums with variable arc of contact, 105.—Description of Imray's break dynamometer, 107.—Belt lined with wood answers best, 109.

*Discussion.*—Bach, R., 115, 117.—Froude, W., 111, 112, 114, 115, 116, 117.—Maudslay, H., 110.—Penn, J., 112, 115, 116, 117.—Siemens, C. W., 113, 116.

DYSON, G., elected Member, 1860, 13.

DYSON, R., elected Member, 1865, 218.

## E.

EALLES, W., elected Member, 1853, 45.

EARNSHAW, W. L., elected Member, 1869, 276.

EASSIE, P. B., elected Member, 1859, 53.

Pile Driver, *Paper* on an improved steam pile-driver with endless chain, 1867, 255.—Working of telescopic pile-driver, 263.—Cost of working, 264.—Rate of working, 265.

EASTON, E., elected Member, 1858, 266.

Engines, Portable, for Mining, particulars of experiments on evaporative duty of Cornish boilers, 1873, 186.—Double-flued Cornish boiler best for stationary purposes, 1873, 187.



EASTON, E. (continued).

Scraper for Torquay Water Works, scraper also used at Barrow, 1873, 230.

—Composition to prevent incrustation in pipes, 231.—Large amount of stuff scraped off, 231.

EASTON, J., elected Member, 1867, 18.

EASTWOOD, J., elected Member, 1856, 79.

EATON, R., Aero-Steam Engine, *Paper* on the Warsop aero-steam engine, 1870, 229.—Entire absence of incrustation, even with very saline water, 237.—Prevention of priming under severe test, 238.—No solid matter passes into cylinder, 238.—Amount of gain from use of air-injection, 242.

EATON'S COKE OVENS. *See* Coke Ovens, 1861, 72.

EDDISON, R. W., elected Member, 1868, 103.

EDMUNDS, H., appointed Treasurer, 1855, 6.

EDMUNDS, J. S. W., elected Graduate, 1873, 25.

EDWARDS, E. J., elected Member, 1871, 21.

EDWARDS, J., Centrifugal Pump, particulars of working, 1852, 108.

EGLESTON, T., Jun., elected Member, 1859, 247.

EICHORN, J., Cupola, *Paper* on an improved cupola for iron foundries, (Krigar's,) 1868, 89.—Reduction in waste of iron, 98.—Calculation of quantity of blast, 100.

EJECTOR CONDENSER. *See* Condenser, Ejector, 1872, 256.

ELCE, J., elected Member, 1866, 264.

ELDER, D., elected Member, 1848, Apl., 23.

ELDER, J., elected Member, 1862, 20.

ELEVATOR, COLLIERY DRAINAGE, *Paper* on an application of Giffard's injector as an elevator for the drainage of colliery works, by C. W. Wardle, 1861, 220.—Arrangement of elevator in pit workings, 220.—Description of elevator, 220.—Depositing box to free steam from water, 221.—Steam pipe from boiler, 222.—Particulars of working, 223.—Suggestions for application of elevator, 223.

*Discussion.*—Cowper, E. A., 228, 229.—Cunliffe, R., 225, 226, 229.—Haden, W., 226.—Lloyd, Sampson, 224, 227, 230.—Lloyd, Samuel, 226.—Marshall, W. P., 228.—Siemens, C. W., 227, 229.—Smith, M., 229, 230.—Tomlinson, J., 230.—Wardle, C. W., 226, 229.—Woods, H., 229.

ELEVATOR, RAILWAY CARRIAGE. *See* Railway Carriage Elevator, 1848, Oct., 17.

ELLIOT, Sir G., elected Member, 1859, 13.

Telegraph Machinery, *Paper* on the paying-out and picking-up machinery employed in laying the Atlantic telegraph cable, 1867, 20.

ELLIOT, W., elected Member, 1865, 53.

ELLIOTT, H. W., elected Member, 1869, 77.

ELLIS, S., elected Member, 1847.



ELOIN'S SAFETY LAMP. *See* Safety Lamp, 1851, Oct., 23.

ELSDON, R., elected Member, 1870, 228.

ELWELL, A., elected Member, 1869, 29.

ELWELL, E., elected Member, 1849, Apl., 32.—Decease, 1858, 2.

ELWELL, T., elected Member, 1860, 89.

ELWELL, W., elected Honorary Member, 1848.

ENDLESS-CHAIN PILE-DRIVER. *See* Pile Driver, 1867, 255.

ENGINE COUNTER, *Paper* on an improved engine counter, by J. Richmond, 1849, Jan., 14.—Simplicity and certainty of action, however rapidly worked, 14.—Dials checked by one another, 15. — Reduced expense, 15.

*Discussion.* — Fothergill, B., 16. — McConnell, J. E., 15, 16. — Ramsbottom, J., 15. — Richmond, J., 15, 16. — Slate, A., 15. — Whitworth, J., 16.

ENGINE DUTY, Cornish, table of, 1873, 200.—Falling off in duty, 97, 190.—Example of very high duty, 190.—High duty of good portable engines, 183.—Duty of portable and Cornish engines, 193.—Stamping engines, 189.

ENGINE SHED, *Paper* on the locomotive engine shed and turntables at the Gateshead Station, by E. Fletcher, 1858, 256.—Arrangement of polygous grouped together, 256.—Roof, 257.—Engine turntables, 258.

*Discussion.*—Armstrong, W. G., 259.—Cowper, E. A., 259.

ENGINE SHED. *See* Workshops, Locomotive, 1851, Jan., 22.

ENGINES, AERO-STEAM. *See* Aero-Steam, 1870, 229.

—AGRICULTURAL. *See* Agricultural.

—AIR. *See* Air, 1856, 145.—1873, 63.

—ALLEN. *See* Allen, 1868, 50.

—ATLAS. *See* Locomotive, 1847, Nov., 3.

—BLOWING. *See* Blowing, and Dowlais.

—CAMBRIAN. *See* Locomotive, 1848, Oct., 13.

—COMPOUND. *See* Blowing, Compound, and Marine.

—COMPRESSED-AIR. *See* Air, 1856, 145.

—CONDENSING. *See* Condensing.

—CORNISH. *See* Pumping.

Piston speed, 1873, 198.—Friction, 182, 198.

—DOUBLE-CYLINDER. *See* Compound.

—EXPANSION. *See* Expansion.

—EXPRESS. *See* Locomotive, 1848, June, 8.—1849, Apl., 8.

—HEATED-AIR. *See* Air, 1873, 63.

—HIGH-PRESSURE. *See* High-Pressure.

—HYDRAULIC. *See* Hydraulic.

—LOCOMOTIVE. *See* Locomotive.

—MARINE. *See* Marine.

ENGINES, PENDULOUS. *See* Pendulous, 1851, Oct., 4.

—PORTABLE. *See* Agricultural, Portable, and Mining.

—PUMPING. *See* Compound, and Pumping.

—RECIPROCATING. *See* Reciprocating, 1850, July, 26.

—ROTARY. *See* Rotary, 1848, July, 3.

—WATER-WORKS. *See* Pumping.

—WINDING. *See* Winding.

ENGINEERING TOOLS, Heavy. *See* Tools, 1864, 189.

ENGLAND, G., elected Member, 1853, 8.

ENGLAND'S SAFETY MINE APPARATUS. *See* Safety Mine Apparatus, 1854, 57.

EQUATORIAL MOTION for Telescopes. *See* Telescope, 1855, 137.

ESCAPE VALVE, *Paper* on an escape water valve, and a governor for marine steam engines, by R. Waddell, 1853, 117.—Damage done by water in cylinder, 117.—Description of escape water valve, 118.—Racing of marine engines in heavy sea, 119.—Marine-engine governor, 120.

*Discussion.*—Beyer, C. F., 121, 122.—Clift, J. E., 121.—Cowper, C., 121.—Gibbons, B., 121.—Ramsbottom, J., 121.

ESSON, W., elected Member, 1861, 109.

ETIENNE, A., elected Member, 1864, 121.

EVANS, D., elected Member, 1848, Apl., 23.

EVANS, J., elected Member, 1850, Apl., 30.

EVANS, J. C., elected Member, 1857, 11.

Steam Crane, *Paper* on a steam crane, 1859, 238.—Successful working of cranes, 240.—Height of lift, and cost of crane, 241.—Engine kept moving slowly when out of gear, 241.—No irregularity of action with one small cylinder running quickly, 242.

EVANS, T., Ventilating Fan, Guibal fan very effective, 1869, 91.—Waddle and Rammell fans, 92.

EVAPORATING APPARATUS for Sugar. *See* Sugar Evaporator, 1856, 179.

EVAPORATING POWER of Tubes, *Paper* on the relative evaporating power of brass and iron tubes, by G. Tosh, 1857, 119.—Brass tubes generally preferred for locomotives, 119.—Description of experimental boilers, 120.—Results of experiments, 121.

*Discussion.*—Craig, W. G., 124.—Fairbairn, W., 124.—Hawkes, W., 124.—Johnson, W. B., 121, 122.—Maudslay, H., 124.—McConnell, J. E., 121.—Rankine, W. J. M., 122.—Roberts, R., 123.—Siemens, C. W., 123.—Tosh, G., 121, 122.

EVERITT, G. A., elected Member, 1848, Apl., 23.

Boiler Tubes, *Paper* on the composition and durability of locomotive boiler tubes in reference to coal-burning, 1867, 46.—Process of testing best-selected copper, 52.—Quality of best-selected copper much deteriorated, 54.

Surface Condensers, brass tubes best for surface condensers, 1863, 160.

EVERITT, W. E., elected Member, 1864, 121.

EYERS, F., elected Member, 1865, 101.

EXCURSIONS, Birmingham, 1860, 176, 247.

Cornwall, 1873, 152, 233.

Dublin, 1865, 164, 215.

Glasgow, 1856, 247.—1864, 187, 265.

Leeds, 1859, 194, 243.—1868, 162, 208.

Liverpool, 1863, 192, 242.—1872, 186, 240.

London, 1862, 145, 209, 312.

Manchester, 1866, 128, 261.

Middlesbrough, 1871, 181, 257.

Newcastle, 1858, 175, 260.—1869, 182, 274.

Nottingham, 1870, 168, 226.

Paris, 1867, 230.

Sheffield, 1861, 170, 208.

EXHIBITION of 1862, Locomotives. *See* Locomotive Engines, 1863, 78.

EXPANSION ENGINE, *Paper* on a continuous expansion steam engine, by J. Samuel, 1852, 27.—Difficulty of carrying out expansion in ordinary engines, 27.—Description of expansion locomotive, 29.—Consumption of coke compared with ordinary engines, 30.—Variation of power throughout stroke in different engines, 31.

*Discussion.*—Jones, E., 34.—McConnell, J. E., 34.—Peacock, R., 34.

EXPANSION ENGINE, *Supplementary Paper* on a continuous expansion steam engine, by J. Samuel, 1852, 41.—Limit to expansion in ordinary locomotives, 42.—Duty obtained from steam in various engines, 43.—General results of application of continuous expansion principle to stationary engines, 46.

*Discussion.*—Clark, D. K., 50.—Cowper, E. A., 52.—Jones, E., 48.—McConnell, J. E., 48, 49, 50.—Samuel J., 48, 49, 51, 52.—Slate, A., 51.—Stephenson, R., 47, 48, 49, 50, 52.

EXPANSION ENGINE, *Paper* on a direct-acting expansive steam engine, by T. T. Chellingworth, 1858, 276.—Principle of construction, 296.—Description of engine, 297.—Starting valve, 297.

*Discussion.*—Chellingworth, T. T., 298, 299.—Clift, J. E., 298.—Fothergill, B., 298.—Inshaw, J., 299.—Maudslay, H., 298.—Smith, I., 299.—Smith, W., 298.

EXPANSION, LOCOMOTIVES, *Paper* on the expansive working of steam in locomotives, by D. K. Clark, 1852, 60.—Necessity of high-pressure steam in locomotives, 61.—Action and capabilities of link motion, 62.—Distribution of steam, 63.—Conclusions from trials of locomotive with shifting link, 65.—Stationary link, 65.—Power lost by exhausting before stroke is completed, 67.—Wire-drawing by link motion, 68.—Compression

## EXPANSION, LOCOMOTIVES (continued.)

of exhaust steam, 68.—Back exhaust pressure at high speeds, 70.—Efficiency of steam worked expansively by link motion, 71.—Table of results from indicator diagrams, 72.—Consumption of water and fuel, 74.—Efficiency of expanded steam in actual practice, 77.—Effective mean pressure, 78.—Table of do., 80.—Consumption of fuel with gab-motion and link motion, 81.—Consumption of water with do., 82.

*Discussion.*—Clark, D. K., 83, 87.—Cowper, E. A., 85, 86.—McConnell, J. E., 83.—Slate, A., 84.—Stephenson, R., 83, 84, 86, 88.

EXPANSION, LOCOMOTIVES, *Supplementary Paper* on the expansive working of steam in locomotive engines, by D. K. Clark, 1854, 109.—Condensation of steam in cylinder by exposure, 109.—Evidence of expansion line of indicator diagrams, 109.—Evidence of condensation in cylinder, 111.—Inside cylinders generally better protected than outside, 113.—Tables of expansion and water equivalents of steam in cylinders of different engines, 115.—Percentage of condensation, 117.—Abstract of working of passenger engine, 121.—Excess of water consumed over that as sensible steam, 122.—Evidence from proportions of valve gear, 124.—Conditions for efficiency of expansion in locomotives, 126.—Superheated steam, 127.

*Discussion.*—Bovill, G. H., 130.—Buckle, W., 128, 129.—Clark, D. K., 129, 130.—Cowper, E. A., 130.—Crampton, T. R., 128, 129, 130.—Peacock, R., 130.—Whytehead, W. K., 130.

EXPANSION, MARINE ENGINES. *See* Marine Engines, 1855. 59, 97.

EXPANSION, STEAM, *Paper* on the expansive action of steam, and a new construction of expansion valves for condensing steam engines, by W. Fairbairn, 1849, July, 21.—Valves worked originally by plug-rod, and by revolving tappets, 22.—Economy of expansive working only recently understood in manufacturing districts, 22.—Prejudice against high-pressure steam in manufacturing districts, 23.—Comparative value of single and double-cylinder engines, 24.—Revolving tappets too slow for efficient expansive action, 25.—Ordinary equilibrium valves at too great distance from cylinder, 26.—Description of improved apparatus, 26.—Series of cams with rollers to vary the expansion, 27.—Certainty and quickness in opening and closing of valves, 28.

*Discussion.*—Beyer, C. F., 28, 30.—Cowper, E. A., 29.—Gibbons, B., 29.—McConnell, J. E., 28, 29, 30.—Slate, A., 29, 30, 31.—Smith, W., 28, 29, 30.

EXPANSION, STEAM, *Paper* on the expansion of isolated steam, and the total heat of steam, by C. W. Siemens, 1852, 131.—Total quantity of heat in steam according to early observers, 132.—Regnault's disproof of Watt's law corroborated, 133.—Apparatus for testing total heat of steam, 134.—

## EXPANSION, STEAM (continued).

Apparatus for experiments on expansion of isolated steam, 135.—Expansion curve, 136.—Rate of expansion greatest near point of saturation, 136.—Rate diminishes in hyperbolic curve towards asymptote representing expansion of permanent gases, 136.—Expanded steam is superheated steam, 138.—Cooling effect of jet of high-pressure steam, 138.—Table of experiments on expansion of isolated steam, 139.

*Discussion.*—Cowper, E. A., 140.—Crampton, T. R., 140.—Siemens, C. W., 140, 141.

EXPANSION VALVE, *Paper* on a double-slide expansion-valve for marine engines, by F. W. Wymer, 1856, 58.—Objects to be effected, 58.—Description of valves, 59.—Table of economy in fuel, 60.

*Discussion.*—Beyer, C. F., 60.—Fenton, J., 60.—Fothergill, B., 60.—Miller, J., 61.—Wymer, F. W., 60, 61.

EXPANSION VALVE MOTION. *See* Valve Motion, 1855, 146.

EXPLOSIONS, BOILER. *See* Boiler Explosions, 1866, 130.—1870, 179.

EXPRESS ENGINE. *See* Locomotive, 1848, June, 8.—1849, Apl., 8.

EYTH, M., elected Member, 1869, 120.

Towing Canal Boats, *Paper* on towing boats on canals and rivers by a fixed wire-rope and clip-drum, 1869, 240.—Action of clip-drum, 264.—Tug-boats worked with "grappin," 267.

## F.

FAIJA, H., elected Member, 1869, 120.

FAIRBAIRN, Sir A., elected Member, 1868, 20.

FAIRBAIRN, G., elected Member, 1854, 49.

FAIRBAIRN, J., elected Honorary Member, 1863, 247.

FAIRBAIRN, T., elected Member, 1852, 9.

FAIRBAIRN, Sir W., elected Member, 1847.—Vice-President, 1853, 7.—President, 1854, 5.—1855, 5.—Vice-President, 1856, 6.—1857, 11.—1858, 12.

Axlebox and Coupling Rod, durability of india-rubber washers when protected from oil, 1858, 169.—Diminished wear of wheel flanges, 170.

Boiler Explosions, importance of periodical inspection, 1866, 165.—Rapid grooving at high pressure, 166.—Strength of tubes to resist collapse varies inversely as their length, 166.

Boiler, French fusible plate, 1854, 103.—Composition of plate, 104.

Colliery, rise of temperature in deep shafts, 1858, 235.—Furnace ventilation necessary for very large quantities of air, 235.

Corn Mill, Floating, *Paper* on a floating steam corn-mill and bakery, 1858, 155.



FAIRBAIRN, Sir W. (continued).

Corn-Mill Machinery, advantage of air current between stones, 1856, 143.

Crane, Travelling, *Paper* on an improved steam travelling crane, 1854, 96.

Crane, Tubular, *Paper* on tubular wrought-iron cranes; with description of the sixty-ton tubular wrought-iron crane recently erected at Keyham Dockyard, Devonport, 1857, 87.—Arrangement of friction rollers, 96.

Expansion of Steam, *Paper* on the expansive action of steam, and a new construction of expansion valves for condensing steam engines, 1849, July, 21.

Guns, Proof of, by Measurement, strain of only one-tenth of limit of elasticity, if frequently repeated, produces fracture, 1866, 109.—Platinum vent-piece, 113.

Iron Columns in Cotton Mill, removal of, *Paper* on the removing and replacing of the iron columns in a cotton mill, 1866, 181.

Library, special donation, 1854, 138.

Marine Engines, increase of steam pressure, 1855, 95.

Pumping Engines, *Paper* on a new construction of pumping engine, 1855, 177.

Railway Break, *Paper* on the retardation and stoppage of railway trains, 1853, 156.

Railway Carriages, saving from less dead weight in long carriages, 1857, 160.

Remarks as President, 1854, 6.—1855, 6.

Resolution in recognition of foundation of Whitworth scholarships, 1868, 163.

Riveter, great strain on standards of most riveting machines, 1856, 137.

Ships, effect of shot on iron armour-plates, 1856, 224.

Spring, failure of springs under long-continued action, 1855, 170.

Steel Tyres, great variation in strength of Bessemer steel, 1866, 196.

Ventilation of Buildings, defective ventilation of barracks, 1867, 77.—Advantage of taking off bad air at bottom of room, 78.

Water Works, Manchester, experiments on velocity of flow through apertures of different shapes, 1866, 258.—Best not to lay pipes through artificial embankment, 260.

Winding Engine, *Paper* on a new description of winding engine, 1853, 137.

FAIRBAIRN, W. A., elected Member, 1849, Jan., 9.

Axlebox and Coupling Rod, *Paper* on an improved construction of axleboxes and coupling rods for locomotive engines, 1858, 166.

FAIRLESS, J., elected Member, 1869, 120.

FAIRLIE, R. F., elected Member, 1857, 201.

FAN BLAST, *Paper* on a series of experiments relative to the fan blast, by W. Buckle, 1847, May, 3.—Fan become indispensable in smithies and



## FAN BLAST (continued).

foundries, 3.—Construction and action, 4.—Experiments on density of blast and power required, 5.—Calculation of results, 6.—Table of experiments, 7.—Greatest results obtained when theoretical velocity and velocity of tips of vanes are nearly equal, 9.—Formula for calculating power, 10.—Proportions of fan deduced from experiments, 12.

FAN BLAST, *Supplementary Paper* on the fan blast, by W. Buckle, 1847, Oct., 3.  
—Size of inlet openings and length of vanes in fan, 4.—Best proportions for construction of fan, 6.—Prevention of noise and reduction of power by contracting discharge opening, 8.—Mechanical construction, 9.—Application of fan to smelting iron, 9.—Tables of additional experiments, 10.

FAN, BLOWING, Lloyd's, 1856, 54, 56.

FAN, VENTILATING. *See* Ventilating Fan, 1856, 251.—1869, 78, 133.—1871, 22, 66.

FARDON, T., elected Member, 1867, 59.

FARMER, J., elected Member, 1862, 93.—Decease, 1864, 2.—Memoir, 14.

FAVIELL, S. C., elected Member, 1865, 101.

FAY, C., elected Member, 1856, 7.

Railway Carriages, *Paper* on saving of dead weight in passenger trains, 1857, 149.—Continuous break acting on every carriage, 159.

FEARN, J. W., elected Member, 1872, 26.

FEARNLEY, T., elected Member, 1861, 211.

FEED-PIPE CONNEXION, *Paper* on a new water connexion between locomotive engines and tenders, by J. Fenton, 1857, 99.—Ball-and-socket couplings and hose pipes very troublesome, 99.—Description of new coupling, 99.

*Discussion.*—Craig, W. G., 101.—Fenton, J., 100, 101, 102.—Forsyth, T., 101.—Johnson, W. B., 102.—Ramsbottom, J., 100.—Rankine, W. J. M., 102.—Siemens, C. W., 102.—Whitworth, J., 102.

FEED-PIPE CONNEXION, *Paper* on a feed-pipe connexion for locomotive engines, by A. Allan, 1862, 88.—Description of coiled-tube connexion, 88.—Examples of elasticity of coiled tube, 89.—Particulars of working, 90.

*Discussion.*—Cochrane, A. B., 90, 91.—Joy, D., 90, 91.—Lloyd, Sampson, 90.—Murphy, J., 91.

FELLOWS, F. P., Decimal Measure, Inch and Metre, importance of complete system of weights and measures based on one unit, 1865, 40.—Comparative values of exports to countries using metric system and English system, 41.—Utility of metric system for engineering calculations, 42.

FENBY, J. B., elected Member, 1866, 103.

Locks, *Paper* on an improved construction of lock and key, 1866, 79.—Provision against locking the bit up in the safe, 100.—Importance of

FENBY, J. B. (continued).

retention of counterfeit bit if once tried, 100.—Necessity for cutting off all access to interior of lock, 101.

Steam Jet, more work done in exhausting same weight of air at greater vacuum, 1872, 115.—Applicable for air-blast between millstones, 115.

FENTON, J., elected Member, 1847.—Council, 1849, Jan.. 9.—Re-elected Member, 1852, 9.—Council, 1854, 5.—Vice-President, 1857, 11.—1858, 12.—1859, 13.—1860, 13.—1861, 13.—1862, 19.—1863, 14.—Decease, 1864, 2.—Memoir, 14.

Feed-Pipe Connexion, *Paper* on a new water connexion between locomotive engines and tenders, 1857, 99.—Durability of india-rubber rings, 101.—Cost of coupling, 102.

Safety Valve, *Paper* on an improved safety valve for locomotive, marine, and stationary boilers, 1855, 24.—Mode of grinding spherical valves, 29.—Cost of single and double valves, 29.

Water-Raising Apparatus, *Paper* on Fryer's apparatus for filling locomotive tenders with water, 1859, 211.

FENWICK, C., elected Graduate, 1869, 277.

FERGUSON, H. T., elected Member, 1870, 19.

Ore-Dressing Machinery, *Paper* on the mechanical appliances used for dressing tin and copper ores in Cornwall, 1873, 119.

FERNIE, J., elected Member, 1854, 110.—Council, 1857, 11.—1860, 13.—1863, 14.—1866, 16.—1869, 19.

Allen Engine, greater pressure of steam advisable at high speeds, as in locomotives, 1868, 75.

Boiler, Corrosion of, welded boilers very satisfactory, 1866, 75.

Coal-Cutting Machinery, *Paper* on the application of machinery to coal cutting, 1868, 135.—Adjusting height of cut from floor, 145.

Crane, *Paper* on a travelling crane worked by clip-drum and wire-rope, 1868, 164.—Speed of lifting with heavy cranes, 168.—Less power required to drive wire-rope than quick-running cotton-rope, 172.

Decimal Measure, *Paper* on the application of the decimal system of measurement to mechanical engineering work, &c., 1859, 110.—Cocker's measuring instrument, error from dust, and very small gauge, 127.

Decimal Measure, *Paper* on the application of the decimal system of measurement in boring and turning wheels and axles, 1860, 223.—Best degree of tightness of wheel on axle, 229.—Inch very convenient unit for decimal measurement, 232.—No difficulty in working to one-thousandth of an inch, 233.

Decimal Measure, Inch and Metre, *Paper* on the relative advantages of the inch and the metre as the standard unit of decimal measure, 1865, 21.—Adoption of metre gauge for manufacture of Giffard injectors, 34.—Metre has no advantage over inch, 50.

FERNIE, J. (continued).

Drilling Machine, important to drill rivet-holes in fireboxes of locomotive boilers, 1860, 207.

Hoist and Cupola, *Paper* on an improved foundry hoist and cupola, 1856, 49.—Working speed of fan, 56.

Hydraulic Shearing Press, great advantage over ordinary shears, in facility for stopping at any point, 1858, 75.

Indicator, improved construction of, 1863, 266.

Injector, experiments with different proportions of steam and water, 1860, 79.

Locomotive Engines, working of Lickey Incline on Midland Railway, 1863, 111.

Packing for Pistons, steam-packed brass rings very durable and preserve cylinder very effectually, 1862, 321.

Pumping Engine, importance of authentic records of working, cost, &c., of beam and direct-acting engines, 1859, 60.

Steam Cultivation, great success of clip-drum, 1865, 80.—Restrictions on use of traction engines on roads quite unnecessary, 81.

Tuyere, *Paper* on an improved tuyere for smiths' hearths, 1855, 57.—Durability of tuyeres, 58.

Ventilation, Mechanical, mistake to admit the fresh air above, 1863, 205.

FESSEL'S GYROSCOPE, description of, 1854, 106.

FIDDES, W., elected Member, 1866, 55.

FIDLER, E., elected Member, 1872, 119.

Coal-Cutting Machine, rate of cutting, 1872, 216.—Saving in amount of slack made, 217.—Stoppages not often occurring from falling-in of roof, 219.—Gain from making less slack in machine-cutting, 223.

FIELD, E., elected Member, 1867, 59.

FIELD, J., elected Member, 1862, 314. Decease, 1864, 2.—Memoir, 15.

FIELD, J., Jun., elected Member, 1861, 211.

FIELD IMPLEMENTS. *See* Agricultural.

FILE-CUTTING MACHINE, *Paper* on a new machine for cutting and forging files, by R. C. Ross, 1856, 226.—Description of machine, 226.—Chisel holder, 227.—Regulating force of blow, 228.—Binding roller for holding down blank, 228.—Feed motion, 229.—Rate and cost of cutting files, 229.

*Discussion*.—Fothergill, B., 230, 231.—Harvey, R., 231.—Johnstone, J., 231.—McFarlane, J., 232.—Neilson, W. M., 231.—Ross, R. C., 230, 231.—Whitworth, J., 230, 232.

FILE-CUTTING MACHINE, *Paper* on file-cutting machinery, by T. Greenwood, 1859, 134.—Opposition of file-cutters to introduction of machinery, 134.—Requirements of a file-cutting machine, 135.—Description of Bernot's machine, 136.—Varying force of blow in cutting taper files, 137.—

**FILE-CUTTING MACHINE** (continued).

Compound adjustable bed for holding blank, 137.—Traversing feed, 138.—Adjustment of blank square to edge of chisel, 138.—Mode of action of machine, 137.—Durability of cutting chisels, 140.

*Discussion.*—Cowper, E. A., 143, 145.—Fothergill, B., 141, 144.—Greaves, S., 145.—Greenwood, T., 141, 142, 143, 144, 146.—Maudslay, H., 144.—Penn, J., 141, 143, 144, 146.—Tomlinson, J., 145.

**FILLITER, E.**, elected Member, 1865, 101.

**FILTER**, *Paper* on an improved water filter, by A. Slate, 1854, 75.—Description of Forster's stone filter, 75.—Cleaning, 76.—Filters for very dirty water, 76.—Separation of lead, 77.

*Discussion.*—Addenbrooke, G., 78.—Bird, A., 77.—Clift, J. E., 78.—Forster, J., 77, 78.—Jobson, R., 78.—Slate, A., 77, 78.

**FIREBRICK GAS RETORTS.** *See* Gas Retorts, 1852, 178.

**FIRTH, A.**, elected Member, 1868, 103.

**FIRTH, S.**, elected Member, 1868, 212.

Coal-Cutting Machinery, compressed-air machine distinctly cools the workings, 1868, 151.—Diminished area of workings kept open with machine cutting, 153.—Whole of undercutting at Tingley Colliery done by machine, 158.—Double-headed pick for holing in one course, 161.

**FIRTH, W.**, Coal-Cutting Machinery, holing in parting to keep two qualities of coal separate, 1868, 147.—Effect of compressed-air machine on ventilation, 151.

**FISHER, B. S.**, elected Member, 1871, 117.

**FISHER, J.**, elected Honorary Member, 1863, 114.

**FISHER, W.**, Puddling Machine, larger yield of iron of better quality, and smaller consumption of fuel than in hand puddling, 1864, 304.—Fettling not disturbed by rabble, 308.—Six heats worked per day, 309.

**FLAVEL, S., Jun.**, elected Graduate, 1867, 60.

**FLAX-SPINNING MACHINERY**, *Paper* on machinery employed in the preparation and spinning of flax, by T. Greenwood, 1865, 103.—Retting, 103.—Scutching, 104.—Heckling, 104.—Spinning, 105.—Sizes of yarn, 106.—Cut-line system, 107.—Breaking rollers, 108.—Scutching machine, 108.—Heckling machine, 109.—Long-line spreading frame, 114.—Tow-carding machine, 117.—Wet spinning frame, 120.

*Discussion.*—Greenwood, T., 122, 123, 124, 125, 127.—Napier, R., 122, 123, 124, 127, 128.—Newton, W. E., 124.—Richardson, W., 123.—Whitley, J., 127.

**FLEET, T.**, elected Member, 1864, 121.

Tools, punched holes equal to drilled, 1864, 217.—Machine riveting not so good as hand, 218.

**FLEETWOOD, D. J.**, elected Member, 1861, 14.

FLETCHER, E., Original Member, 1847.

Engine Shed, *Paper* on the locomotive engine shed and turntables at the Gateshead Station, 1858, 256.

FLETCHER, H., elected Member, 1872, 75.

FLETCHER, H. A., elected Member, 1858, 266.

FLETCHER, J., elected Member, 1857, 201.

Break Drums, general employment of cast-iron bearings for cast-iron shafts, &c., 1871, 210.

Rifled Gun Manufacture, difficulty in producing accurate work, from change of temperature, 1862, 144.

Tools, *Paper* on improvements in heavy tools for general engineering and iron shipbuilding work, 1864, 189.—Durability of punch of nut-making machine, 209.—Defects of punched plates for wrought-iron bridge building, 212.—Accuracy of drilling plates for riveting, 213.—Skew-mitre wheels for drill spindles, 219.—Speed of drilling, 220.—Setting of drills, 221.—Circular shaping machine for planing edges of plates, 225.—Angle of V grooves of planing machine should not be more than 85°, 227.—Stepped rack for planing machine, 227.

FLETCHER, J., Jun., elected Member, 1866, 264.

FLETCHER, L. E., elected Member, 1867, 59.

Boiler Explosions, plain cylindrical boiler not a safe form, 1866, 172.—Great injury done by explosions of boilers heated by puddling and other furnaces, 173.—Lancashire boiler safest form, 174.—Construction of internal flues, 175.—All explosions caused by neglect, 1870, 200.—Results of explosion due to force of steam alone, 200.—Explosions attributable mostly to boiler-owner, 200.—Necessity for frequent examination, 201.—Proportions and fittings of boilers, 201.

FLOATING DOCKS. *See* Docks, Floating, 1867, 80.

FLOATING STEAM CORN-MILL. *See* Corn Mill, Floating, 1858, 155.

FLOOD, P. B., elected Member, 1866, 264.

FLOUR MILL, Disintegrating. *See* Disintegrator, 1872, 28.

FLOW OF SOLIDS, *Paper* on the "Flow of Solids", with the practical application in forgings, &c., by H. Tresca, 1867, 114.—Experiments on flow of cylindrical jet of lead, 114.—Points noted in experiments, 115.—Further experiments on cylindrical jets, 116.—Flow through polygonal and eccentric circular orifices, 119.—Flow through lateral orifices, 122.—Conclusions from experiments, 125.—Experiments on rolling and forging, 126.—Rolling, 128.—Forging, 133.—Punching, 138.—General conclusions on flow of solids, 141.

*Discussion.*—Clay, W., 148.—Cochrane, C., 148.—Fairbairn, W., 145.—Fernie, J., 147, 149.—Mallet, R., 145, 147.—Newton, W. E., 147.—Penn, J., 150.—Ramsbottom, J., 144, 146.—Tresca, H., 143, 144, 147, 149.



- FLOWER, J. J. A., elected Member, 1872, 254.
- FOGG, R., elected Member, 1859, 247.
- FORREST, W. J., elected Member, 1871, 262.
- FORSTER, E., elected Member, 1861, 14.
- FORSTER, G. B., elected Member, 1869, 276.
- FORSTER, G. E., elected Honorary Member, 1863, 247.
- FORSTER, J., elected Member, 1868, 103.
- FORSTER WATER FILTER. *See* Filter, 1854, 75.
- FORSYTH, J. C., elected Member, 1849, Apl., 32.
- FORSYTH, T., elected Member, 1849, Apl., 32.—Decease, 1859, 2.
- Axlebox, successful action of cotton-waste in keeping axle lubricated, 1852, 222.
- Boiler, *Paper* on a new steam-engine boiler, 1854, 101.—Pressure plate, to give way when pressure too high, 104.
- Drilling Machine, *Paper* on a double-traversing drilling and grooving machine, 1856, 108.—Time and cost of cutting cotter-holes by hand and by machine, 111.—Fixing drills in spindles, 112.
- FOSTER, E. H., elected Member, 1864, 19.
- FOSTER, S. L., elected Member, 1861, 109.
- FOSTER PRESSURE GAUGE. *See* Pressure Gauges, 1871, 281.
- FOTHERGILL, B., Original Member, 1847.—Council, 1847.—1848.—1849, Jan., 9.—1853, 8.—Vice-President, 1856, 6.—1857, 11.—1858, 12.—1859, 13.—1860, 13.
- Brick Machinery, *Paper* on a dry-clay brick-making machine, 1859, 42.—Edges of mould not worn away as in former machines, 48.—Cost of the machinery, 49.
- Coal-Burning Locomotive, saving from use of coal, 1858, 289.—Tubes and fireboxes more durable with coal than with coke, 290.—Saving from use of coal in Lancashire, 1860, 172.—Importance of brick arch as well as deflecting plate, 172.—Slower combustion advisable in locomotives, 175.
- Combing Machine, *Paper* on the combing of fibrous materials, 1853, 151.
- Cotton-Spinning Machinery, spinning jeunty still used in spinning wool for cloth, 1866, 242.
- File-Cutting Machine, opposition of workmen to introduction of machines, 1859, 141.—Importance of correct form of tooth, 142.—Machine-cut files quite equal to best hand-cut files in working, 144.
- Friction Coupling, *Paper* on Wrigley's friction coupling for shafting, 1858, 22.—Use of friction couplings in starting machinery without shock, 25.
- Hoist Governor, *Paper* on a safety hoist governor, 1858, 269.—Cost, 271.
- Meeting at Newcastle, and Excursions, 1858, 267.
- Rope Manufacture, defects in preparation of fibres, 1862, 202.—Combing machine better than carding for cotton fibres, 204.

FOTHERGILL, B. (continued).

Steel Tyres, *Paper* on Banks' steel tyres, 1848, Apl., 21.

Teeth of Wheels, mode of describing teeth for wheel and pinion, 1848, Apl., 5.

Water Meter, *Paper* on an improved water meter, 1853, 142.—Small friction in Taylor's meter, 145.

Water Meter, *Paper* on recent improvements in water meters, 1857, 172.—Efficiency of Chadwick's piston meter, 176.

FOUNDRY, *Paper* on an iron construction of foundry, and an improved process of moulding pipes and hollow cast ware, by J. Downie, 1856, 165.—Arrangement of moulding shop, 165.—Columns, girders, &c., 165.—Swing cranes, 166.—Roof, 167.—Improved method of moulding, 167.—Moulding apparatus, 168.

*Discussion.*—Beyer, C. F., 170.—Downie, J., 169, 170, 171, 172.—Fairbairn, W., 169.—Fenton, J., 169.—Fothergill, B., 172.—Harvey, R., 171.—Jones, E., 172.—McFarlane, J., 171, 172.—Morrison, R., 170.—Whitworth, J., 169, 171, 172.

FOUNDRY CUPOLA. *See* Cupola, 1856, 49.—1868, 89.

FOWLER, G., elected Member, 1866, 17.

Colliery Working, Midland, *Paper* on the mode of working and the mechanical appliances employed in the Midland coalfield, 1870, 146.—Winding engine has to be much more powerful than necessary to raise load, 164.

FOWLER, J., elected Member, 1847.

FOWLER, J., Jun., elected Member, 1857, 55.—Decease, 1865, 2.—Memoir, 14.

Steam Cultivation, *Paper* on steam cultivation, 1857, 57.—Cost of steam ploughing machinery, 75.

Steam Cultivation, *Paper* on the application of steam power to cultivation, 1865, 55.

FOWLER, W., elected Member, 1859, 53.

FOX, Sir C., Original Member, 1847.—Council, 1856, 6.—1863, 14.—1866, 16.—1869, 19.

Decimal Measure, actual unit not of much importance, 1857, 143.—Comparison of French and English measures, 144.—Metre not correct decimal fraction of degree of latitude, 144.

FOX, C. D., elected Member, 1866, 55.

FRANKISH, J., elected Member, 1864, 121.

FRASER, JOHN, elected Member, 1859, 53.

FRASER, JOSEPH, elected Member, 1853, 8.

FRASER, J. S., elected Member, 1866, 264.

FREEMAN, G. F., elected Member, 1870, 228.

FREEMAN, J., elected Member, 1856, 79.—Decease. 1872, 2.—Memoir, 16,

FREEMAN, W. G., elected Associate, 1873, 250.

FRICTION of Heated-Air Engine, 1873, 73.—Cornish engines, 182, 198.—Loss of power by engine friction, 198.

FRICTION BREAK, Appold. *See* Dynamometer, 1858, 107.—Telegraph Machinery, 1867, 24.

—Balk. *See* Dynamometer, 1858, 107.

—Imray. *See* Dynamometer, 1858, 107, 113.

—Weston. *See* Friction Coupling, 1868, 214.

FRICTION COUPLING, *Paper* on Wrigley's friction coupling for shafting, by B. Fothergill, 1858, 22.—Description of coupling, 22.—Adjustment for wear, 23.—Importance of application of friction couplings, 23.

*Discussion.*—Cochrane, A. B., 26.—Cowper, E. A., 26.—Fothergill, B., 24.—Whitworth, J., 24, 25, 26.—Wrigley, F., 24, 26.

FRICTION COUPLING, *Paper* on an improved friction coupling and break, and its application to hoists, windlasses, and shafting, &c., by T. A. Weston, 1868, 214.—Principle of repeating frictional effect, 214.—Model illustrating principle, 215.—Experimental break, 216.—Materials and structure of discs, 218.—Graduated-effect break, 219.—Hoisting crab, 220.—Sack hoist, 220.—Ship's windlass, 221.—Shaft coupling, 223.—Safety clutch, 224.—Self-engaging friction coupling, 224.—Lathe coupling, 225.—Safety pinion, 225.—Self-sustaining sack-hoist, 226.—Hoisting crab for slow lowering, 229.—Hoisting crab for quick lowering, 230.

*Discussion.*—Batho, W. F., 235.—Bramwell, F. J., 235, 236.—Carbutt, E. H., 236.—Cowper, E. A., 233, 234.—Siemens, C. W., 236.—Weston, T. A., 232, 233, 234, 235, 236.

FRICTION GEARING, *Paper* on grooved-surface frictional gearing, by J. Robertson, 1856, 202.—Description of gearing, pitch of grooves, 202. Speed ring, 203.—Disengaging clutch, 204.—Reversing gear, 204.—Testing apparatus, 205.—Comparative slip in grooved and toothed wheels, 206.—Pressure required to hold wheels in gear, 207.

*Discussion.*—Fairbairn, W., 209, 211.—Harvey, R., 211.—McFarlane, J., 212.—Robertson, J., 209, 210, 211, 212.—Russell, J. S., 210.—Siemens, C. W., 211.—Whitworth, J., 209, 210, 212.

FRICTION HAMMER. *See* Hammer, 1854, 133.

FROST, T., elected Member, 1864, 59.—Decease, 1872, 2.—Memoir, 16.

FROUDE, W., elected Member, 1852, 153.

Dynamometer, *Paper* on a new dynamometer and friction break, 1858, 92.

Morin's dynamometer very accurate, 111.—Oil-cylinder necessary to prevent jerks, 111.—Large amount of power absorbed by thrashing machines running empty, 112, 115.—Advantages of Imray's friction break over other forms, 113.

FROUDE, W. (continued).

Engines, Portable, for Mining, friction of engines of screw ship, 1873, 199.

Scraper for Torquay Water Works, roughness of pipe greatly impedes flow of water, 1873, 224.—Mode of ascertaining nature of obstruction, 225.—Effect of trial scraping, 226.—Experiment showing resistance of rough surfaces to flow of water, 227.—Construction of scrapers, 227.—Action of stone-collecting cup, 229.—Cost of first scraping, 229.

Ship Model Machine, *Paper* on a machine for shaping the models used in experiments on forms of ships, 1873, 202.—Correspondence of models with calculated displacement, 212.—Paraffin cuts very easily and clean, 213.—Size of models, 214.—Great strength of paraffin models, 215.

FRY, A., elected Member, 1866, 264.

FRYER, A., Water-Raising Apparatus, direct application of steam for raising saccharine fluids, 1859, 214.—Raising water from well where pump failed from valves being inaccessible under water, 215.—Very little steam required for filling locomotive tender, 215.

FUEL, COMPRESSED PEAT. *See* Peat Fuel, 1865, 147.

FUEL ECONOMISER, *Paper* on an apparatus for economising fuel, by W. G. Craig, 1857, 196.—Description of Green's economiser, 196.—Soot scrapers, 196.—Temperature of waste heat and of feed water, 197.—Economy in fuel, 197.

*Discussion.*—Craig, W. G., 198.—Leese, 198, 199.—Maudslay, H., 199.—McConnell, J. E., 198, 199.

FURNACE, BLAST. *See* Blast Furnace.

FURNACE, REGENERATIVE. *See* Regenerative Furnace.

FURNACE, REVOLVING CHEMICAL, *Paper* on a revolving furnace for chemical works, by R. C. Clapham and H. C. Allhusen, 1869, 229.—Extent of "balling" process, 229.—Construction of revolving furnace, 229.—Joints at ends of cylinder, 230.—Rotating apparatus, 230.—Cylinder bearings, 231.—Particulars of working, 231.—Comparison in cost, &c., with hand-furnace, 232.

*Discussion.*—Allhusen, H. C., 234, 236, 238.—Armstrong, Sir W. G., 234, 239.—Bell, I. L., 234, 236.—Bramwell, F. J., 238.—Clapham, R. C., 239.—Clay, W., 236.—Cochrane, C., 235.—Cowper, E. A., 238.

FURNACE VALVE, *Paper* on Prideaux's self-closing valve for preventing smoke in steam-boiler and other furnaces, by J. E. Hodgkin, 1854, 111.—Principle of action, 111.—Description of apparatus, 111.—Regulating cylinder, 112.—Deflecting plates, 112.—Coolness of stoke-hole, 113.—Size of air-valve, 114.—Consumption of smoke, 114.—Saving of fuel, 115.

*Discussion.*—Fairbairn, W., 116, 119.—McConnell, J. E., 117, 118.—Prideaux, T. S., 117, 118, 119.

GAINSFORD, W. D., elected Member, 1865, 53.

GALE, J. M., Water Works, Glasgow, *Paper* on the mechanical appliances of the Loch Katrine Water Works for the supply of Glasgow, 1864, 123.—Water supply for various purposes, 138.—Partial use of meters, 139.—Heavy cost of general use of meters, 140.—Water-rate in Glasgow, 140.—Small stop-valves in large mains, 143.—Connection of aqueduct and pipes, 145.—Provision against accidents, 146.

GALLOWAY, C. J., elected Member, 1866, 103.

Boiler Explosions, strengthening internal flues by conical transverse tubes, 1866, 176.

GALTON, D., Capt., elected Member, 1862, 314.

GARLAND, W. S., Original Member, 1847.

Pumping Engines, *Paper* on the new pumping engines at the Birmingham Water Works, 1853, 110.—Expansion of steam, 114.—Pressure of water, 115.—Flywheel pumping engine higher duty than Cornish, 1858, 62.—Description of pumping engine at Stoke Newington, 62.

GARSTANG, J. H., elected Member, 1870, 228.

GAS LIGHTING for Trains, *Paper* on lighting railway trains with gas, with description of T. J. Thompson's system, by J. Kitson, 1857, 242.—American system of gas lighting for trains, 242.—Thompson's system, description of gasholder combined with tender, 244.—Consumption of burners, 245.—Gasholder in guard's van, 246.—Supply gasometer at stations, 247.—Self-acting gas valve, 248.—Coupling between carriages, 249.—Cost of lighting train with oil and with gas, 251.—Cost of gasholders, &c., 252.

*Discussion.*—Chellingworth, T. T., 255.—Clift, J. E., 253, 256, 257.—Cowper, E. A., 255.—Fernie, J., 257.—Inshaw, J., 258.—Jones, J. H., 255.—Lloyd, Sampson, 252, 254, 257, 258.—Markham, C., 255, 256.—Thompson, T. J., 252, 254, 255, 256, 257.—Wright, H., 258.

GAS METER, *Paper* on an improved gas meter, by A. Allan, 1860, 15.—Variable registering by ordinary gas meters, 15.—Description of improved meter, 15.—Compensating fountain, 16.—Protection from any tampering with registration, 17.—Simpler modification of meter, 18.

*Discussion.*—Clift, J. E., 19, 20.—Kennedy, J., 21.—Siemens, C. W., 20.

GAS RETORTS, *Paper* on improved fire-brick gas retorts, by J. E. Clift, 1852, 178.—Requirements of gas retorts, 178.—Gas produced during each half hour of working with iron and fire-brick retorts, 179.—Description of fire-brick retorts, 180.—Durability, 181.—Cost of iron and fire-brick retorts, 182.

*Discussion.*—Chellingworth, T. T., 184.—Clift, J. E., 184, 185.—Ramsbottom, J., 185.—Wright, H., 185.

GASSE, A., elected Member, 1860, 13.



- GAUGE, MAGNETIC WATER. *See* Magnetic Water Gauge, 1860, 83.
- GAUGE, PRESSURE. *See* Pressure Gauge.
- GAUGE, VACUUM. *See* Vacuum Gauge, 1851, Jan., 27.
- GAUNTLETT, W. H., elected Member, 1867, 18.
- GEACH, C., Original Member, 1847.—Decease, 1855, 4.
- GEARING. *See* Frictional Gearing, 1856, 202.—Teeth of Wheels, 1848, Apl., 4.  
—Wheel Moulding Machine, 1855, 41.—1868, 238.
- GELLERAT, E., Steam Road Roller, *Paper* on the steam road roller used in Paris, 1869, 101.
- GIBBINS, R. C., elected Member, 1871, 262.
- GIBBINS, T., elected Member, 1848, July, 20.
- GIBBONS, B., elected Member, 1848, Apl., 23.  
Blast Furnaces, importance of large aperture at top of furnace, 1852, 201.  
—Only small saving in fuel by use of waste gases, 204.  
High-Pressure Boilers, open safety-pipe for indicating over-pressure or deficiency of water, 1848, July, 16.  
Locomotive Boiler, air heated more efficiently in bent pipes than straight pipes for hot-blast furnaces, 1849, July, 9.  
Pneumatic Lift, *Paper* on a pneumatic lift, 1849, July, 11.—Lift can be stopped firm in any position, 20.—Railway trains might be raised without motion being felt, 20.—Not considerable loss from friction, as in hydraulic cranes, 20.—Original suggestion for utilising pressure of blast for a lift, 1851, Jan., 8.  
Ventilation of Colliery, plan of working in Staffordshire superior in economy and efficiency, but coal much thicker, 1849, July, 38.  
Ventilation of Mines, *Paper* on the ventilation of mines, 1851, Apl., 8.—  
Mode of extracting whole of pillars of coal, 35.—Increased yield of coal, 35.
- GIBBONS, B., Jun., elected Member, 1860, 89.—Decease, 1864, 2.—Memoir, 16.
- GIBBS, W., elected Member, 1865, 53.
- GIBSON, J., elected Member, 1870, 228.
- GIFFARD INJECTOR. *See* Injector, 1860, 39, 74.—1861, 220.—1866, 266.
- GILBERT, E. E., elected Member, 1872, 254.
- GILKES, E., elected Member, 1856, 250.—Council, 1868, 19.—1870, 18.—1873, 24.  
Break Drums, cast-iron break blocks on Stockton and Darlington Railway, 1871, 210.
- GILLIES, M., elected Member, 1869, 120.
- GILROY, G., elected Member, 1866, 17.  
Coal-Cutting Machinery, machine required to be easily portable, 1868, 159.  
Corn Warehousing Machinery, travelling band used for conveying slack from coal screens, 1869, 223.

**GIRDERS, NASMYTH, *Paper*** on Nasmyth's girders and fire-proof floors, by Sampson Lloyd, 1849, Oct., 27.—Adaptations of "bow-and-string" principle, 27.—Fire-proof floors, with plate iron fitted in bow-and-string form, 27.—Freedom from lateral pressure on girders, 27.—Application to girders and bridges, 28.—Roadway of bridges formed with arched plates like fire-proof floors, 29.—Roofs constructed with extreme lightness, 29.—Application to dock-gates, caissons, and piers, 29.—Great saving in weight of materials, 30.

*Discussion.*—Cowper, E. A., 31, 32.—Henderson, J., 31.—Lloyd, Sampson, 30, 31.—Slate, A., 32.—Stephenson, R., 30, 31, 32.

**GLASGOW COALFIELD.** *See* Coalfield, Glasgow, 1864, 229.

**GLASGOW Summer Meetings,** 1856, 125.—1864, 121.

**GLASGOW WATER WORKS.** *See* Water Works, Glasgow, 1864, 123.

**GLASS, PLATE, *Paper*** on machinery for the manufacture of plate glass, by G. H. Daglish, 1863, 209.—Extent of manufacture in England, 209.—Casting and annealing of plates, 210.—"Fly-frame" grinding machine, 211.—Smoothing machine, 213.—Polishing machine, 213.—Improved grinding and smoothing machine, 214.—Further improvements wanted in casting the plates, 216.

*Discussion.*—Adamson, D., 220.—Bramwell, F. J., 217, 220, 221.—Clay, W., 223.—Danson, W., 220.—Ferne, J., 219.—Newton, W. E., 222.—Pilkington, R., 219, 220, 221.—Silvester, J., 221.—Windus, 217, 220.

**GLASS, POLISHED SHEET, *Paper*** on the processes and mechanical appliances in the manufacture of polished sheet glass, by R. Pilkington, 1863, 268.—Melting and blowing, 268.—Furnaces, 269.—Pots, 269.—Blowing, 271.—Flattening, 272.—Polishing, 274.—Emery-sorting apparatus, 275.—Polishing with red oxide of iron, 276.

*Discussion.*—Bramwell, F. J., 278.—Clift, J. E., 278.—Cowper, E. A., 280.—Lloyd, Sampson, 277, 279, 280.—Pilkington, R., 277, 278, 280.—Rigby, P., 277, 280.

**GLYDON, G.,** elected Graduate, 1850, July, 43.

**GODFREY, S.,** elected Member, 1862, 93.

**GOLD,** extraction by amalgamation. *See* Crusher, 1854, 33.

**GOOCH, W. F.,** elected Member, 1867, 234.

**GOODE, B. W.,** elected Member, 1854, 49.

**GOODEVE, T. M.,** elected Member, 1869, 120.

**GOODFELLOW, B.,** Original Member, 1847.—Decease, 1864, 2.—Mémor, 16.

**Boiler Construction, *Paper*** on the construction and durability of steam boilers, 1859, 217.—Bulging of end plate of boiler from expansion of internal flue, 223.—Angle-iron strong enough if good iron and not injured by drifting, 226.

GOOLD, Capt., Brick Making, cost of making bricks in machine at Cobham, 1859, 258.—Clay used raw from pit, 260.—Brick made of nearly pure silica, 260.

GÖRANSSON, G. F., elected Member, 1865, 101.

GORDON, R., elected Member, 1852, 41.

GORMAN, W., Water Meter, *Paper* on an improved water meter, 1856, 242.

GÖSSELL, O., elected Honorary Member, 1865, 20.

GOUGH, N., elected Member, 1848, Apl., 23.

GOVAN COLLIERY, Compressed-Air Engine. *See* Compressed-Air Engine, 1856, 145.

GOVERNOR, *Paper* on a simple construction of steam-engine governor, having a close approximation to perfect action, by J. Head, 1871, 213.—Action of a governor, 213.—Conical pendulum, 215.—Parabolic action, 216.—Original Watt governor, 217.—Parabolic governor, 218.—Mode of laying down approximate parabolic governor, 219.—Description of governor, 221.—Particulars of governors at work, 222.—Increased error in ordinary Watt governors, 223.

*Discussion.*—Head, J., 224, 227, 228.—Olrick, L., 224, 228.—Ramsbottom, J., 228.—Siemens, C. W., 226.—Thompson, W., 228.

GOVERNOR, *Paper* on the Allen governor and throttle-valve for steam engines, by F. W. Kitson, 1873, 47.—Watt governor inefficient for sudden change in load, 47.—Allen governor successful in rolling mill, 48.—Detailed description, 49.—Spiral adjusted to nature of load, 50.—Weight adjusted to required speed of engine, 51.—Special packing in stuffing-box of oil-cylinder, 52.—Governor driven by gearing better than belt, 52.—Throttle-valve construction, 52.—Ratio of area of valve to engine-cylinder, 53.—Particulars of governors in use, 54.

*Discussion.*—Bramwell, F. J., 58.—Brogden, H., 59.—Olrick, L., 59.—Siemens, C. W., 57, 58, 60.—Walker, B., 56, 57.—Whitley, J., 55, 58.

GOVERNOR, CHRONOMETRIC, *Paper* on an improved governor for steam engines, by C. W. Siemens, 1853, 75.—Defects of Watt governor, 76.—Hick's fly governor, 77.—Pneumatic or cataract governors, 78.—Siemens' chronometric governor, 79.—Heavy conical pendulum and break, 80.—Applications and delicacy of action, 81.—Modified form of governor, 82.—Great power of action on valve, 82.—Improved throttle-valve, 82.

*Discussion.*—Blackwell, S. H., 85, 86, 87.—Clift, J. E., 86.—Cowper, C., 86.—May, C., 86.—McConnell, J. E., 84.—Siemens, C. W., 83, 84, 85, 86.—Slate, A., 83, 84.

GOVERNOR, CHRONOMETRIC, *Paper* on an improved chronometric governor for steam engines, &c., by C. W. Siemens, 1866, 19.—Original governor with conical pendulum, 19.—Substitution of open parabolic cup for pendulum, 20.—Description of improved chronometric governor, 21.—Differential

## GOVERNOR, CHRONOMETRIC (continued).

gear, 22.—Action of governor, 23.—Power of governor to maintain constant speed, 24.—Chronometric governor for regulating clockwork, &c., 26.—Principles of action, 27.—Adjustment of rise and fall of cup, 29.—Electric clock, 30.—Clock may be tilted out of vertical position, 30.

*Discussion.*—Amos, C. E., 41, 42.—Bramwell, F. J., 34, 40.—Cowper, E. A., 34, 42.—Fairbairn, W., 37, 38, 39.—Napier, R., 32, 33, 34, 40, 42.—Neilson, W. M., 40.—Siemens, C. W., 32, 33, 34, 37, 39, 40, 41.

GOVERNOR, MARINE, *Paper* on a marine engine governor, by P. Jensen, 1859, 92.—Necessity of governor to marine engines, 92.—Former governors, 93.—Description of new governor, 93.—Application to paddle vessels, 94.

*Discussion.*—Jensen, P., 95.—Maudslay, H., 95, 96.—Smith, W., 94, 96.

GOVERNOR, MARINE. *See* Escape Valve, 1853, 117.

GOVERNOR, SAFETY, for Hoist. *See* Hoist Governor, 1858, 269.

GOW, J., elected Member, 1848, Apl., 23.

GOWENLOCK, A. H., elected Member, 1871, 21.

GRAINGER, J. N., elected Graduate, 1869, 277.

GRAINGER, T., elected Member, 1848, Apl., 23.

GRANET, J. A., elected Member, 1858, 266.

GRANTHAM, J., Double-Cylinder Engines, cause of excess of pressure at end of stroke, 1862, 271.—Economy of double-cylinder engines, 272.—High pressure necessary for great economy, 273.—Various arrangements of double-cylinder engines, 274.

Telegraph Cables, cable-sheathing not exposed to same conditions as ship-sheathing, 1862, 233.—Siemens' cable likely to prove durable, 233.

GRAY, JAMES, elected Member, 1848, Apl., 23.

GRAY, JOHN, elected Member, 1847.

GRAY, Sir JOHN, Rock-Boring Machine, difficulty of working in small tunnel either by hand or by machine, 1865, 198.

Water Works, Dublin, hardness of Dublin well water, 1865, 209.—Mode of charging for water supply, 210.—Supply of Glasgow and Manchester, 211.—Periodical flushing of sewers preferable to continuous small stream, 213.

GRAY, J. M. F., elected Member, 1865, 218.

Air Engine, Heated, very little effective pressure in middle of stroke, 1873, 78.—Mean effective pressure very low, 78.—Air not capable of one third the expansion of steam, 79.

Hydraulic Machines, difficult to apply machine riveters to shipbuilding, 1872, 204.—Hydraulic riveter better than steam riveter, 204.—Compressed-air riveter, 204.

Marine Engines, variation in tangential force absorbed by inertia of vessel, &c., 1872, 168.—Flywheel to reduce loss by slip, 169.—Important

GRAY, J. M. F. (continued).

to have high-pressure cylinder large enough in compound engines, 170.—  
Desirable not to have too high steam-pressure, 170.

Pumping Engines, sudden rise of pressure on closing of air-pump valve, 1867, 247.—Wear of valves from irregular opening, 248.—Grids with series of round holes, 252.

Riveter, Portable Steam, riveting a ship's side, 1865, 138.—Speed of riveting, 139.—Weight of hammer piston, 139.—Steam pipe, 139.—Allowance for rivets not square to plate, 141.—Cost of machine, 144.—Cost of riveting, 144.—Experiment to test durability of machine, 145.

Steering Engine, Steam, *Paper* on the steam steering engine in the "Great Eastern" steamship, 1867, 267.—Very little lap to slide-valves, 281.—Failure of plan of steering by main screw, 283.—Steering much more prompt with rudder than with twin screws, 285.—Steering without headway, 286.—Yielding of rudder to excessive strain, 287.

Surface Condensers, pitting of boiler due to particles of brass from tubes, 1863, 157.—Objectionable to use same water repeatedly for boilers, 158.

GRAY, M., elected Member, 1870, 125.

GREAT EASTERN STEAMSHIP, Steering Engine. *See* Steering Engine, Steam, 1867, 267.

GREAVES, C., Cornish Pumping Engines, *Paper* on the relations of power and effect in Cornish pumping engines over long periods of working, 1862, 147.—Clearance space in cylinder, 159.—Very great expansion not desirable in single-cylinder engines, 160.—Working expenses, cost, &c., 161.—Duty of Cornish engines, 167.

Water Meter, piston meters not successful, 1856, 119.—Working of Siemens meters, 120.

GREAVES, J. H., elected Member, 1870, 61.

GREEN, C., elected Member, 1848, Apl., 23.—Decease, 1867, 2.—Memoir, 14.

GREEN, E., Jun., elected Member, 1861, 109.

GREEN'S Fuel Economiser. *See* Fuel Economiser, 1857, 196.

GREENER, J. H., elected Member, 1871, 262.

GREENWELL, G. C., elected Member, 1867, 18.

GREENWOOD, T., elected Member, 1858, 45.—Council, 1868, 19.—1870, 18.—1873, 24.

Cartridge Machinery, *Paper* on the machinery for the manufacture of the Boxer cartridges, 1868, 105.—Difficulty in making base of cartridge strong enough to stand explosion, 129.—Great accuracy requisite in fitting base-cup punches, 130.—Copper not very successful for base cups, 131.—Accuracy of weight of bullet, 132.—Weight of complete cartridge, 133.—Repeating rifles, 133.—Blank cartridges, 134.

Disintegrator, successful in preparing roman cement, 1872, 45.—No fermentation in flour ground with steel rollers because not heated, 50.



## GREENWOOD, T. (continued).

File-Cutting Machine, Bernot's, *Paper* on file-cutting machinery, 1859, 134.—Cost of cutting bastard files by hand and by machine, 142.—Increased durability of chisel when used in machine, 142.—Rapidity of cutting round files, 144.—Zinc bed for file to rest on, 146.

Flax-Spinning Machinery, *Paper* on machinery employed in the preparation and spinning of flax, 1865, 103.—Cost of flax mill, 123.—China grass, 123.—Preparing china grass, 125.—Mixing with wool or silk, 126.—Room for further improvements in flax machinery, 128.

Gunstock Machinery, *Paper* on machinery for the manufacture of gunstocks, 1862, 328.—Rate of production of gunstocks by machines, 335.—Speed of cutters, 337.—Cost of machines, 337.—Adjusting position of gunstock in machines, 337.—Time for putting together a gun complete, 339.—Copying lathe originated in England, 340.

GREGORY, J., elected Member, 1857, 232.

GREIG, D., elected Member, 1865, 53.

Crane, difficult to keep cotton ropes in repair, 1868, 169.—Strain on wire rope, 170.

Steam Cultivation, *Paper* on the application of steam power to cultivation, 1865, 55.—Difficulty of comparing cost of steam and horse cultivation, 79.—No necessity for clod-crushers, &c., after steam-ploughing, 82.—Power of engines, 84.—Traction engine not successful for ploughing, 85.—Effect of steam ploughing, 86.—Use of steam ploughs for sugar and cotton plantations, 87.—Draining plough, 88.—Large stones turned up without injury, 89.—Cost of machine, 89.—Durability of ropes, 90.—Best size of fields, 91.

GRICE, E. J., elected Member, 1866, 17.

GRICE, F. G., elected Member, 1860, 250.

GRIERSON, H. H., elected Member, 1868, 212.

GRIFFITHS, J. A., elected Associate, 1873, 88.

GRIFFITHS Screw Propeller. *See* Screw Propeller, 1852, 163.

GRIMSHAW, W. D., elected Member, 1865, 53.

Compressed-Air Hammer, *Paper* on a high-speed compressed-air hammer, for planishing, stamping, forging, &c., 1865, 94.—Alteration of working pressure, 97.—Speed of blows, 97.—Cost, 98.—Drawing-down steel, 98.—Durability of working parts, 100.

GROVER, G. E., Capt., elected Member, 1871, 117.

GROSMONT IRON WORKS. *See* Iron Works, 1863, 225.

GRUBB, T., Printing Machine for Bank Notes, *Paper* on the bank-note printing machine at the Bank of Ireland, 1865, 166.—Pressure on printing roller, 174.—Process of engraving the steel plates, 174.—Renewing impression on steel plates, 175.

GUERGUIN, P. A. H., elected Member, 1858, 12.

GUIBAL VENTILATING FAN. *See* Ventilating Fan, 1869, 78, 140.

GUILFORD, F. L., elected Member, 1870, 125.

GUN MANUFACTURE. *See* Rifled Gun Manufacture, 1862, 125.

GUNS, PROOF OF, by Measurement, *Paper* on the proof of guns by measurement, with description of the instrument employed, by J. Whitworth, 1866, 105.  
—Proportions of projectile and charge, 105.—Description of measuring instrument, 106.—Trials of 70-pounder Whitworth gun, 107.

*Discussion.*—Bramwell, F. J., 110, 111.—Fairbairn, W., 109, 113, 114.—Fothergill, B., 110.—Kennan, J., 113.—Maudslay, H., 113.—Napier, R., 110, 114.—Whitworth, J., 109, 110, 111, 113, 114.

GUNSTOCK MACHINERY, *Paper* on machinery for the manufacture of gunstocks, by T. Greenwood, 1862, 328.—Series of operations in manufacture of gunstocks, 329.—Lock-bedding machinery, 330.—Mode of compensating for wear of drills, 331.—Shaping machine with revolving cutters for shaping gunstock between the bands, 332.

*Discussion.*—Beyer, C. F., 335, 336, 337, 338, 340.—Bramwell, F. J., 338, 339, 340.—Ferne, J., 339.—Greenwood, T., 335, 336, 337, 338, 339, 340.

GURDEN, C. F., elected Member, 1866, 17.

Marine Engines, compound engines generally more efficient than single-cylinder, 1872, 175.—Centrifugal pump better than reciprocating for surface condensers, 176.—Advisable to have damper in funnel, 176.

GWYNNE, J., elected Member, 1870, 61.

GWYNNE, J. E. A., elected Member, 1870, 61.

GWYTHIER, E., elected Honorary Member, 1850, Apl., 30.

GYROSCOPE, Fessel's, description of, 1854, 106.

## H.

HACKNEY, W., elected Honorary Member, 1863, 247.

Wire-Rope Bridge, *Paper* on a wire-rope bridge at the Landore Steel Works, for conveying materials across a navigable stream, 1870, 249.—Cost of bridge, 255.—Cost and rate of working, 255.

HADDAN, J. C., elected Member, 1847.

HADEN, W., elected Member, 1861, 109.

HÆMATITE IRON Manufacture. *See* Iron Manufacture, Hæmatite, 1871, 18.

HAGGIE, P., elected Member, 1861, 109.

Rope Manufacture, hemp should not undergo too much preparation, 1862, 203.—Test for yarn, 203.—Machine-made ropes superior to hand-made, 205.—Steel wire not much stronger than iron, 206.—Strength of iron wire ropes, and of hemp ropes, 207.—Strength of steel wire ropes, 208.—Hemp ropes advantageous if not too long, 208.

HALKETT, J. C., elected Member, 1864, 271.

HALL, JOHN, elected Honorary Member, 1865, 20.

HALL, JOSEPH, elected Member, 1863, 246.

HALL, W., elected Member, 1857, 201.

Iron Works, Round Oak, steam hammer better than helve for shingling, 1860, 221.

HALL, W. S., elected Member, 1871, 65.

HALPIN, D., elected Member, 1871, 21.

HAMAND, A. S., elected Member, 1870, 19.

HAMBLING, T. C., elected Member, 1869, 77.

HAMILTON, G., elected Member, 1860, 89.

Pumping Engines, *Paper* on the Crossness pumping engines for the Metropolitan Main Drainage Works, 1867, 236.—Consumption of coal, 243.—Breakage of flaps with narrow seats, 246.—Leather valves probably best for sewage, 253.—India-rubber disc-valves, great loss of area of opening, 253.—Duty of Crossness engines double that of best centrifugal pump, 254.

HAMMER, COMPRESSED-AIR, *Paper* on Waterhouse's compressed-air forge hammer, by C. F. Beyer, 1858, 118.—Description of hammer, 118.—Adjustment of force of blow, 119.—Facility of control, 120.

*Discussion.*—Bach, R., 122.—Froude, W., 122, 123.—Marshall, W. P., 122.—Maudslay, H., 122.—Penn, J., 121, 123.—Siemens, C. W., 121, 123.—Waterhouse, T., 121, 122.

HAMMER, COMPRESSED-AIR, *Paper* on a high-speed compressed-air hammer, for planishing, stamping, forging, &c., by W. D. Grimshaw, 1865, 94.—General description of hammer, 94.—Air-pump, 94.—Slide-valve, 95.—Adjustment of speed of blows, 95.—Special features, 96.

*Discussion.*—Adames, C. H., 99.—Bellhouse, E. T., 97.—Bramwell, F. J., 97, 98, 99, 100.—Carbutt, E. H., 98.—Grimshaw, W. D., 97, 98, 99, 100.—Richardson, W., 97, 99.

HAMMER, FRICTION, *Paper* on an improved friction hammer, by J. Kitson, 1854, 133.—Description of hammer, 133.—Friction break, 134.—India-rubber springs to prevent shock, 135.

*Discussion.*—Fairbairn, W., 135, 136, 137.—Ferne, J., 137.—Johnson, W. B., 137.—Lloyd, Sampson, 136.—Lloyd, Samuel, Jun., 137.—McConnell, J. E., 136, 137.—Middleton, W., 136.

HAMMER, HORIZONTAL DUPLEX, *Paper* on a 30-ton horizontal duplex hammer, by J. Ramsbottom, 1867, 218.—General description, 218.—Hammer tups, 219.—Wheels, 219.—Piston-rods, 219.—Valve-chests, 220.—Connecting screw, 220.—Girders and foundation, 221.—Ingot trucks and rocking table, 221.—Truck for ordinary ingots, 222.—Tyre truck, 223.—Truck for bars, 224.—Truck for long shafts, 224.—Peel bar, 225.—Character of work, 225.—Chief advantages, 226.

## HAMMER, HORIZONTAL DUPLEX (continued).

*Discussion.*—Cochrane, C., 228.—Penn, J., 227, 229.—Ramsbottom, J., 227, 228, 229.

HAMMER, STEAM, *Paper* on an improved steam hammer, by R. Morrison, 1855, 8.—Objections to Nasmyth and Condie hammers, 8.—Description of improved hammer, 9.—Steam pressure, 9.—Slide-valve and gear, 11.—Convenience of working, 12.

*Discussion.*—Beyer, C. F., 17.—Chellingworth, T. T., 14.—Cowper, E. A., 16.—Fairbairn, W., 13, 14, 17.—Fenton, J., 14.—Forsyth, T., 14.—Fothergill, B., 17.—Henderson, J., 15.—Maudslay, H., 16.—May, W., 14.—Morrison, R., 13, 14.

HAMMER, STEAM, *Paper* on Naylor's double-acting steam hammer, by C. Markham, 1857, 233.—Introduction of high-speed hammers, 233.—Effect of height of fall, and of double-action of hammer, 234.—Description of improved hammer, 235.—Adjustment of valve to work single or double-acting, 235.—Valve gearing and sliding wedges, 236.—Small hammer for riveting, 237.—Advantages of double-acting hammer, 238.

*Discussion.*—Eastwood, J., 239, 240.—Lloyd, Sampson, 239, 240, 241.—Markham, C., 239.—Naylor, W., 240, 241.

HAMMER, STEAM, *Paper* on a steam hammer for light forgings, by R. Peacock, 1860, 284.—Description of hammer, 284.—Valve with adjustable lap, 284.—Fastening of piston-rod to hammer-head, 285.—Indicator diagrams and results of working, 285.

*Discussion.*—Bramwell, F. J., 288, 290.—Cowper, E. A., 289.—Inshaw, J., 292.—Markham, C., 289.—Maudslay, H., 287, 292.—Naylor, W., 291.—Peacock, R., 287, 289, 290, 291, 292.—Siemens, C. W., 289.—Williams, R., 290.

HANDLEY, W., Railway Break, *Paper* on an improved break for railway carriages, 1852, 19.

HANNAH, J. E., elected Member, 1870, 61.

HARDING, G. E., elected Member, 1870, 125.

HARDING, J., elected Member, 1858, 79.—Decease, 1872, 2.—Memoir, 17.

HARDING, W., elected Member, 1847.

HARDY, J., elected Member, 1866, 17.

HARFIELD, W. H., elected Member, 1869, 20.

HARLOW, J., elected Member, 1849, July, 39.

HARMAN, H. J., elected Member, 1873, 250.

HARMAN, H. W., elected Member, 1859, 247.

Boiler Construction, gusset stays should not be omitted, 1859, 225.—

Importance of good circulation; mechanical means of effecting this, 225.

Railway Bridge Piers, difficulty in sinking iron cylinders in the Trent, 1863, 24.

HARMAN, H. W. (continued).

Ships, Iron, punched holes in some respects better than drilled for riveting, 1863, 142.

HARRIS, R. H., elected Member, 1873, 45.

HARRISON, G., elected Member, 1856, 49. — Council, 1862, 19. — 1865, 19. — 1868, 19. — 1870, 18. — 1872, 25.

HARRISON, J. E., elected Member, 1871, 117.

HARRISON, T. E., elected Member, 1858, 45.

HARRISON, W., elected Member, 1865, 218.

HARRISON, W. A., elected Member, 1865, 102.

HARRISON Cast-Iron Steam Boiler. *See* Boiler, Cast-Iron, 1864, 61.

HARTAS, I., elected Member, 1863, 113.

HARTNELL, W., elected Member, 1872, 75.

HARTNESS, J., elected Member, 1871, 117.

HARTREE, W., elected Member, 1848, Apl., 23. — Decease, 1860, 2.

HARVEY, R., Foundry, steam cranes most convenient in a foundry, 1856, 171.

Frictional Gearing, advantage in slipping when too great strain occurs, 1856, 211.

Riveter, *Paper* on an improved steam riveting, punching, and shearing machine, 1856, 134. — Pressure at end of stroke in riveting, 137. — Rapidity of working, 138. — Machine regulated by hand, 138.

Sugar Evaporator, *Paper* on an improved sugar evaporating apparatus, 1856, 179. — Successful working of Bour pan, 181. — Preliminary scumming, 183.

Surface Condenser, mode of forming joints at end of tubes, 1856, 192.

HARVEY, W. B. B., elected Member, 1859, 13. — Decease, 1861, 2.

HASSALL, H. T., elected Member, 1872, 254.

HASTE'S Safety Valve. *See* Safety Valve, 1859, 186.

HASWELL, J. A., elected Member, 1858, 12.

Break Drums, *Paper* on the break drums and the mode of working at the Ingleby Incline on the Rosedale branch of the North Eastern Railway, 1871, 200. — Saving from use of cast-iron break blocks instead of wood, 205. — Speed of working, 206. — Durability of cast-iron break blocks, 207.

Railway Switch, *Paper* on an improved railway switch, 1858, 171.

HAUGHTON, S. W., elected Member, 1857, 55.

HAWARD, F., elected Member, 1856, 79.

HAWKES, W., elected Honorary Member, 1857, 56. — Decease, 1863, 2. — Memoir, 13.

Brick-Making, absorption of water by bricks, 1859, 260. — Dimensions of bricks in various countries, 262.

HAWKINS, C. W., elected Member, 1873, 25.

HAWKINS, W. B., elected Member, 1861, 211.

HAWKSLEY, C., elected Member, 1870, 61.



- HAWKSLEY, T., elected Member, 1856, 7.—Council, 1862, 19.—Vice-President, 1868, 19.—1869, 19.—1870, 18.—1871, 20.—1872, 25.—Council, 1873, 24.
- Boiler Explosions, carbonate of magnesia more injurious to plates than carbonate of lime, 1870, 204.
- Coal-Cutting Machinery, compressed air superior to water for transmitting power in mines, 1868, 161.
- Cornish Pumping Engines, double-acting engines in most cases preferable to single-acting for pumping, 1862, 168.—Cornish engine advantageous where fuel is very expensive, 168.
- Double-Cylinder Engines, single-cylinder best where load uniform, 1862, 279.—Double-cylinder often best for water works, 280.—Limit to economy from increased expansion, 280.—Destructive action of high-pressure steam on engine and boiler, 282.
- Pressure Gauges, Bourdon and diaphragm gauges both failed under sudden heavy pressures, 1871, 290.—Air-gauge the only reliable one for very high pressures, 291.
- Steam Boilers, Mechanical Firing, chief advantage is prevention of smoke, 1869, 172.—Relative economic effect of large and small coal, 174.
- Surface Condenser, reason for Hall's original condenser being abandoned, 1862, 111.—Experiment on horizontal and vertical tubes, 119.
- Telegraph Cables, pure metals rapidly destroyed in water, 1862, 237.—Conducting core of large diameter necessary for long cables, 238.
- Towing Canal Boats, no loss from oblique pull on wire-rope, 1869, 270.—Canal navigation much neglected, 271.—Skeleton locks for towing barges through, 272.
- Valve Gear, indicator figure not to be depended on alone, 1868, 188.—Friction break gives erroneous results, 188.
- HAWTHORN, R., elected Member, 1848, Apl., 23.—Council, 1858, 12.—1861, 15.—Vice-President, 1864, 18.—1865, 19.—1866, 16.—1867, 17.—Decease, 1868, 2.—Memoir, 15.
- HAWTHORN, W., elected Member, 1848, July, 20.
- HAY, J. A. C., elected Member, 1873, 87.
- HAYNES, T. J., elected Member, 1862, 314.
- HEAD, JEREMIAH, elected Member, 1859, 247.—Re-elected, 1869, 120.
- Engines, Portable, for Mining, experiment showing long time required for complete combustion, 1873, 180.—Proportion of fuel falling into ash-pit in different boilers, 181.—Portable engine not steady enough for permanent work, 181.—Economy of Cornish boilers due to very slow firing, 188.
- Governor, *Paper* on a simple construction of steam-engine governor having a close approximation to perfect action, 1871, 213.—Comparison of action with Watt governor, 224.—Action of spiral spring in governor, 227.

## HEAD, JEREMIAH (continued).

Mining District of Cornwall, Cornish iron ore valuable as fettling for puddling furnaces, 1873, 117.

Towing Canal Boats, no loss of power in wire-rope towing, 1869, 269.

HEAD, JOHN, elected Member, 1860, 89.

HEAD, T. H., elected Member, 1858, 45.

HEADLY, J. I., elected Member, 1853, 75.

HEADLY, L., elected Member, 1873, 87.

HEALEY, E. C., elected Member, 1857, 201.

HEANE, H., elected Honorary Member, 1848, Apl., 24.

HEAP, W., elected Member, 1872, 119.

HEARTH AND TUYERE. *See* Tuyere, 1855, 57.

HEATED-AIR ENGINE. *See* Air Engine, 1873, 63.

HEATH, W. J. W., elected Member, 1862, 93.—Decease, 1870, 2.—Memoir, 14.

HEATH'S RAILWAY BREAK. *See* Break, Railway, 1853, 156.

HEATHCOTE, C., elected Member, 1848.

HEATHFIELD, R., elected Member, 1864, 59.

HEATON, G., elected Member, 1860, 89.

Condensing Engine, *Paper* on the importance of making a compensation for the pull of the air-pump bucket in the condensing steam engine, 1850, Apl., 26.

HEATON, J., elected Member, 1868, 212.

HEATON, R., Steam Road Roller, annual saving from use of roller, 1869, 111.

HEDLEY, J., elected Member, 1858, 79.—Decease, 1865, 2.—Memoir, 15.

HEMP ROPE MANUFACTURE. *See* Rope Manufacture, 1862, 170.

HENDERSON, D. M., elected Member, 1869, 20.

HENDERSON, J., Original Member, 1847.—Council, 1855, 5.—Vice-President, 1856, 6.—Decease, 1859, 2.

Nasmyth Girders, cast iron preferable to wrought iron for arched rib, 1849, Oct., 31.

Steam Hammer, importance of elastic foundation for anvil, 1855, 15.—Hammer supported on long girders, 15.

HENNET, G., Original Member, 1847.—Decease, 1858, 2.

HENSON, H. H., elected Member, 1850, Apl., 30.

Railway Wagons, *Paper* on improvements in the construction of railway wagons, 1851, July, 3.

HEPTINSTALL, J., elected Member, 1865, 102.

HETHERINGTON, J. M., elected Member, 1865, 102.

Boiler, Cast-Iron, Harrison, very successful working, 1864, 89.—

Temperature of waste heat, 89.—Saving of coal, 90.

HETHERINGTON, T. R., elected Member, 1866, 17.

HETHERINGTON, W. I., elected Member, 1864, 121.

HEWETT, E. E., elected Graduate, 1865, 54.

HEWITSON, W. W., elected Member, 1848, July, 20.—Decease, 1864, 2.—  
Memoir, 17.

HEWLETT, A., elected Member, 1872, 119.

HEWLETT, W. H., elected Associate, 1872, 26.

HEYWOOD, J., Decimal Measure, Inch and Metre, advantages from introduction  
of metric system, 1865, 45.

HICK, J., Original Member, 1847. —Re-elected, 1871, 65.— Council, 1872, 25.

Starting Apparatus, *Paper* on a starting and disengaging apparatus, 1849,  
Jan., 16.

HICKMAN, G. H., elected Member, 1853, 75.—Re-elected, 1866, 55.

HIDE, T. C., elected Member, 1864, 271.

HIGH-PRESSURE BOILER. *See* Boiler, High-Pressure, 1848, July, 11.—1859,  
264.—1861, 30, 94.—1871, 229.

HIGH-PRESSURE ENGINE. *See* Boiler, High-Pressure, 1861, 94.

HIGSON, J., elected Member, 1870, 61.

HILDEBRANDT, J. A. R., elected Member, 1873, 88.

HILL, A. C., elected Member, 1871, 262.

Blowing Engines, *Paper* on the improved compound-cylinder blowing  
engines at the Lackenby Iron Works, Middlesbrough, 1871, 175.

Blowing Engines, *Paper* on the working of the improved compound-cylinder  
blowing engines and Howard boilers at the Lackenby Iron Works,  
Middlesbrough, 1872, 274.— No trouble with balanced valves after  
first adjustment, 281.—Time and labour requisite for cleaning Howard  
boilers, 285.—Lackenby blowing engines highly satisfactory, and  
considerable economy, 287.—Saving in cost of water per ton of iron  
made, 287.

HILL, H. W., elected Graduate, 1867, 60.

HILL, I., Coal-Cutting Machine, very serviceable in long-wall workings, 1864,  
293.—More applicable to thin than to thick seams, 294.

HILTON, F., elected Member, 1873, 45.

HIND, H., elected Member, 1869, 120.

HIND, R., elected Member, 1863, 113.

HINGLEY, S., elected Member, 1862, 47.

HOBBS, A. C., elected Member, 1859, 53.

HOBY, J. W., Original Member, 1847.

Permanent Way, *Paper* on the construction of permanent way, 1849,  
Apl., 21.

HODGE, P. R., Original Member, 1847.

Axlebox and Crossing, *Paper* on a new self-lubricating axlebox for railway  
engines and carriages, and a self-acting spring crossing point, 1852, 213.

HODGE, P. R. (continued).

Locks, *Paper* on the progress of improvements in locks in the United States of America, 1851, June, 16.

Marine Engines, Allen's proposed engine too short in cylinders, 1855, 119.—

High pressures used in American steamers, 121.

Station Buffer, resisting power of teeth doubtful, but better principle than spring, 1849, Jan., 14.

Tuyere, American hearth with vertical tuyere at bottom, 1855, 128.

HODGES, P., elected Member, 1870, 19.

HODGKIN, J. E., elected Member, 1854, 5.

Furnace Valve, *Paper* on Prideaux's self-closing valve, for preventing smoke in steam-boiler and other furnaces, 1854, 111.

HODGKINSON, E., elected Honorary Life Member, 1849, Jan., 9.—Decease, 1862, 3.—Memoir, 14.

HODGSON, C., elected Member, 1866, 55.

Peat Fuel, *Paper* on the manufacture of compressed peat fuel, 1865, 147.—

Value of peat fuel, 154.—Not suitable for blast furnaces, 154.—Importance of air-drying peat before removal from bog, 157.—Gas from mixture of peat and cannel coal, 159.—Time of drying, 160.—Space occupied by a ton of peat, 160.—Wire ropes not applicable for working the harrows, 161.—Durability of steel tube of press, 161.—Drying by current of hot air not practicable, 163.

HODGSON, R., elected Member, 1858, 79.

Bridge, Hydraulic Swing, construction and testing of piers, 1869, 128.

HOIST AND CUPOLA, *Paper* on an improved foundry hoist and cupola, by J. Fernie, 1856, 49.—Particulars of working, 50.—Description of hoist, 50.—Weight lifted, 51.—Ireland's cupola, 52.—Mode of charging, 52.—Repairing, 53.—Lloyd's blowing fan, 54.—Prevention of noise in working of fan, 55.—Consumption of fuel, 56.

*Discussion.*—Beyer, C. F., 56.—Cochrane, A. B., 57.—Fernie, J., 56, 57, 58.—Fothergill, B., 56, 57, 58.—Williams, R., 56.—Wright, H., 57.

HOIST GOVERNOR, *Paper* on a safety hoist governor, by B. Fothergill, 1858, 269.—Principle of action, and description of governor, 269.—Safety catch for breakage of winding rope, 270.

*Discussion.*—Fothergill, B., 271, 272, 273.—Lloyd, Sampson, 273.—Maudslay, H., 272, 273.—Siemens, C. W., 272.—Smith, W., 271.

HOLCROFT, J., elected Member, 1852, 9.

HOLCROFT, T., elected Member, 1866, 55.

HOLIDAY, J., elected Member, 1871, 117.

HOLLAND, G., elected Graduate, 1867, 60.

HOLLIDAY, J., elected Member, 1865, 102.

HOLLOW RAILWAY AXLES. *See* Axles, 1853, 87.

HOLROYDE, J. B., elected Honorary Member, 1859, 54.

HOLT, F., elected Member, 1863, 246.

Counter-pressure Steam Break, early trial of counter-pressure working on South Staffordshire Railway, 1870, 54.

HOLT, H. P., elected Member, 1873, 25.

HOLT, W. L., elected Member, 1867, 59.

HOMER, C. J., elected Member, 1867, 234.

HOMER HILL COLLIERY, Ventilating Fan. *See* Ventilating Fan, 1869, 78.

HOMERSHAM, S. C., elected Member, 1848, July, 20.

HOPKINS, J. I., elected Member, 1860, 89.

HOPKINS, J. S., elected Member, 1866, 17.

HOPKINS, T., Telescope, Equatorial, adjustment of regulating syphon, 1855, 142.

—Rate of flow of water at different temperatures, 143.

HOPKINSON, J., elected Member, 1856, 7.

HOPPER, G., elected Member, 1858, 80.

HOPPER, W., elected Member, 1867, 18.

HÖRNBLOWER, J. W., elected Honorary Member, 1864, 60.

HORROCKS, S., elected Member, 1867, 18.

HORSLEY, C., elected Member, 1873, 88.

HORSLEY, T., Jun., elected Member, 1868, 20.

HORSLEY, W., Jun., elected Member, 1858, 80.

HORTON, E., elected Member, 1868, 43.

HORTON, G., elected Member, 1871, 65.

HORTON, JOHN, Original Member, 1847.

HORTON, JOSHUA, elected Member, 1851, Apl., 45.

HORTON, T. E., elected Member, 1867, 59.

HOSKIN, R., elected Member, 1873, 88.

HOSKING, J., elected Member, 1858, 12.—Decease, 1872, 2.—Memoir, 17.

Pump Valves, *Paper* on improvements in pump valves, 1858, 249.—Lift of large valves, 254.

HOSKING, J., Jun., elected Member, 1873, 45.

HOSKYNS, C. W., Steam Cultivation, questionable whether plough is best form of steam-power cultivator, 1857, 70.

HOT-BLAST STOVES, *Paper* on the construction of hot-blast ovens for iron furnaces, by H. Marten, 1859, 82.—Old belief that the colder the blast, the better the yield of blast furnace, 62.—Neilson's first hot-blast apparatus, 63.—Cast-iron heating retort, 64.—Long heating pipes in flues, giving blast of 600° Fahr., 64.—First real cast-iron tubular oven, 66.—First application of waste heat at tunnel-head to heating the blast, 68.—Syphon-pipe oven, 69.—Various forms of continuous-pipe ovens, 70.—Double and triple ovens for greater supply of blast, 72.—Mode of obviating fracture of pipes when blast shut off from furnace, 73.—



## HOT-BLAST STOVES (continued).

Fracture of syphon pipes from expansion, 74.—Oven with one main on rollers to allow for expansion, 75.—Expansion of pipes used as pyrometer, 76.—Sections of various oven pipes, 76.—Improved Staffordshire ovens, 77.—Round oven with straight upright pipes, 80.—Round oven with core, 82.—Oval oven with core, giving blast at 800° Fahr., 83.—Cleaning the ovens, 84.—Gauntlett's pyrometer very useful, 85.—Consumption of coal, 86.

*Discussion.*—Everitt, G. A., 88.—Lloyd, Sampson, 87, 88, 89.—Lloyd, Samuel, 90.—Marten, H., 87, 89, 91.—Maudslay, H., 87, 89, 90.—Smith, W., 89.

*Adjourned Discussion.*—Brown, R., 107.—Jones, E., 107.—Markham, C., 106.—Marten, H., 101, 104, 108, 109.—Maudslay, H., 78.—Neilson, J. B., 98, 105, 108.—Smith, H., 108.—Whitworth, J., 104, 107, 108, 109.

HOT-BLAST STOVES, *Paper* on the further economy of fuel in blast furnaces, derivable from the high temperature of blast obtained with Cowper's improved regenerative stoves at Ormesby, and from increased capacity of furnace, &c., by C. Cochrane, 1870, 62.—Description of stoves, 62.—Purifying blast-furnace gas from dust, 64.—Improvements in construction of regenerator, 65.—Hot-blast valve, 66.—Provision for expansion of brickwork, 66.—Capacity of stoves, 67.—Temperature of escaping gas, 67.—Temperature of blast, 68.—Cost of stoves, 69.—Annual cost of regenerative and of cast-iron stoves, 70.—Fluctuation in temperature of blast, 71.—Saving of coke from increased temperature of blast, 72.—Saving of coke from increased capacity of furnace, 74.—Highly heated blast beneficial for anthracite furnaces, 79.—Economy probable from reduction of ore before charging into furnace, 79.

*Discussion.*—Addenbrooke, G., 107.—Bell, I. L., 80.—Bramwell, F. J., 100.—Cochrane, C., 88, 102, 107.—Cowper, E. A., 87, 91, 105, 108.—Ramsbottom, J., 88, 108.—Rose, H. F., 107.—Whitwell, T., 94, 105.

HOT-BLAST STOVES, REGENERATIVE, *Paper* on some regenerative hot-blast stoves working at a temperature of 1300° Fahr., by E. A. Cowper, 1860, 54.—Limited temperature of blast from cast-iron stoves, 54.—Regenerative principle, 55.—Description of new regenerative hot-blast stoves, 57.—Hot-blast valve, 57.—Temperature of blast, 58.—Pyrometer, 59.—Stove heated by waste gas, 60.—Advantages of improved arrangement of stoves, 60.

*Discussion.*—Bramwell, F. J., 72.—Cochrane, C., 69, 71.—Cowper, E. A., 63, 70, 72.—Fernie, J., 72, 73.—Lloyd, Samuel, 71.—Marshall, W. P., 73.—Marten, H., 70.—Neilson, J. B., 65, 69, 71.—Siemens, C. W., 64, 68, 73.

HOUGHTON, J. C. A., elected Member, 1866, 55.

HOWARD, E., elected Member, 1864, 19.

HOWARD, J., elected Member, 1860, 13.

HOWARD, R. L., elected Member, 1867, 59.

HOWARD BOILERS at Lackenby Iron Works. *See* Blowing Engines, 1872, 274.

HOWE, W., elected Member, 1860, 89.

Colliery Working, Midland, only small lap to valves of winding engines, 1870, 167.—Endless chain very advantageous for hauling, 167.

Cornish Pumping Engines, description and cost of pumping engine at Clay Cross Colliery, 1862, 166.

Pumping Engine, *Paper* on the Cornish pumping engine with wrought-iron beam, and the pit work at Clay Cross Colliery, 1863, 248.—Cornish engine less liable to derangement than crank engine, 262.—Clack valves best for pumps, 264.—Cost of engine, &c., 266.—Joints of rising main, 266.

HOWELL, J., Original Member, 1847.

HOWELL, J. B., elected Member, 1861, 109.

HOYLE, W. J., elected Member, 1866, 264.

HUBER, P. E., elected Member, 1862, 93.

HUDSWELL, W. S., elected Member, 1868, 212.

HUFFAM, F. T., elected Member, 1861, 53.

HUGHES, G. D., elected Member, 1867, 18.

Safety Valve, *Paper* on a self-acting safety and fire-extinguishing valve for steam boilers, 1870, 219.—Opens slowly for low water and gives ample warning before fire put out, 224.—Valves with very small faces most reliable, 225.

HUGHES, H., elected Member, 1873, 25.

HUGHES, JOHN, elected Member, 1847.

HUGHES, JOSEPH, elected Member, 1871, 262.

HULSE, W. W., elected Member, 1864, 271.

HUMBER, W., elected Member, 1857, 11.

HUMPHRYS, E., Original Member, 1847.—Council, 1847.—1848.—1849, Jan., 9.—1851, Jan., 8.—1863, 14.—1866, 16.—Decease, 1868, 2.—Memoir, 15.

Pump, Horizontal V, friction increases directly with height of lift, 1864, 41.

Surface Condenser, *Paper* on surface condensation in marine engines, 1862, 99.—Means of washing-out condenser, 106.—Condensing surface per H. P., 110.—Cost of tape packings, 111.—Condensing surface in Hall's original condensers, 113.—Experiment with condensers of "Mooltan," 114.—Superheating steam, 122.—Water lubrication for cylinders, 123.

HUMPHRYS, R. H., elected Graduate. 1866, 265.

HUNSTONE, W. H., elected Member, 1870, 19.

HUNT, E., Marine Engine, *Paper* on a direct-action marine engine for screw propulsion, 1856, 159.

HUNT, J. P., elected Member, 1859, 53.

HUNT, T., elected Member, 1856, 250.

Railway Springs, *Paper* on a new construction of railway springs, 1858, 160.

HUNTER, J. L., elected Member, 1872, 75.

HUNTER, M., Jun., elected Member, 1862, 20.

HURRY, H. C., elected Member, 1860, 13.

HUSBAND, W., Engines, Portable, for Mining, experiments on evaporative duty of Welsh coal with Cornish boilers, 1873, 178.—Portable engines good for trial shafts, but fixed engines best for permanent working, 179.—Average consumption of Cornish engines, 179.—Compound marine engines very low consumption, 179.—Combined horizontal engine for stamping, 180.—High-pressure condensing engine best for winding, 180.—Rate of consumption in Cornish boilers, 188.—Firing, 189.—Duty of stamping engines, 189.—Friction of Cornish engines, 198.

Ore-Dressing Machinery, particulars of working of pneumatic stamps, 1873, 143.—Mode of ensuring regular wear of stamp head, 144.—Packing of pistons in pneumatic stamps, 145.—Tin lost in slimes, 149.

HUTCHINSON, E., elected Member, 1864, 271.

HUTCHINSON, G., Hydraulic Machinery, precaution against freezing of water, 1868, 31.—Methylated spirit and oil seldom used, 32.—Hemp packing for rams, 32.—Leathers for pistons, 32.—Utilising weight of descending loads, 37.—Working pressures, 38.

HUTCHINSON, W. (Newcastle), Original Member, 1847.

HUTCHINSON, W. (Hartlepool), elected Honorary Member, 1860, 53.

HUTTON, W. S., elected Member, 1863, 113.

HYDE, H., Col., elected Member, 1865, 53.

HYDRAULIC ENGINE, *Paper* on a new hydraulic engine, by D. Joy, 1857, 184.—Description of engine, 184.—Peculiarity of valve action, 185.—Wood face for valve, 185.

*Discussion*.—Johnson, W. B., 187.—Joy, D., 186, 187, 188.—Maudslay H., 188.—McConnell, J. E., 186, 188.—Pilkington, R., 187, 188.—Smith, W., 186.

HYDRAULIC MACHINERY, *Paper* on water-pressure machinery, by W. G. Armstrong, 1858, 126.—First idea of utilising head of mountain streams, 126.—First hydraulic cranes, 127.—Accumulator, 128.—Pumping engine, 129.—Present extent of application of water-pressure machinery, 129.—Hydraulic crane, 130.—Variation of power with single cylinder, 130.—Swinging gear for cranes, 131.—Relief valves to prevent over-strain, 132.—Lock-gate closing apparatus, 133.—Water-pressure rotary engines, 134.—Swing bridge, 135.—Rapidity of transferring trucks from ferry to railway, 135.—Various applications of hydraulic power, 136,

## HYDRAULIC MACHINERY (continued).

*Discussion.*—Anderson, J., 140.—Armstrong, W. G., 138, 142.—Fairbairn, W., 139, 144.—Harrison, T. E., 141.—Sopwith, T., 139, 141.—Whitworth, J., 145.

HYDRAULIC MACHINERY, *Paper* on the transmission of power by water pressure, with the application to railway goods stations, forge and foundry cranes, and blast-furnace hoists, by Sir W. G. Armstrong, 1868, 21.—Accumulator, 21.—Comparison of water-pressure and shafting for conveying power, 22.—Non-elasticity of water, 23.—Relief valves, 23.—Compressed-air machinery, 24.—Shipping coal direct from barges, 25.—Hydraulic machinery at Paris and Lyons Railway goods station, 25.—Single-power crane, 26.—Double-power crane, 26.—Capstan engine, 27.—Modifications of hydraulic crane, 27.—Forge cranes, 28.—Blast-furnace hoists, 29.

*Discussion.*—Bramwell, F. J., 39.—Clay, W., 35.—Cowper, E. A., 31, 33.—Howard, E., 38.—Hutchinson, G., 31, 32, 35, 37, 38.—Lloyd, Sampson, 30, 32, 35, 41.—Mallet, R., 40.—Webb, F. W., 35.

HYDRAULIC MACHINERY, *Paper* on the application of water pressure to shop tools and mechanical engineering work, by R. H. Tweddell, 1872, 188.—Three methods of distributing power, 188.—Differential accumulator, 190.—Friction of hydraulic machines, 191.—Special leather collar, 191.—Durability of leathers, 192.—Working pressure, 192.—Application of water pressure to shop machines, &c., 194.—Hydraulic tube-expander, 194.—Machine riveting, 195.—Steam riveter, 195.—Hydraulic riveter, 196.—Portable riveter, 199.—Movable riveter for large marine boilers, 200.—Joints for pressure-pipes, 201.—General application of hydraulic machinery to works, &c., 201.

*Discussion.*—Adamson, D., 205.—Cochrane, C., 205.—Cooper, L., 208.—Gray, J. McF., 204.—Olrick, L., 203.—Siemens, C. W., 209.—Tweddell, R. H., 203, 206.

HYDRAULIC MACHINERY for Warehousing Grain. *See* Corn Warehousing Machinery, 1869, 208.

HYDRAULIC SHEARING PRESS, *Paper* on a hydraulic shearing press, by C. Little, 1858, 70.—Objections to ordinary lever shears, 70.—Description of Eastwood's hydraulic shears, 70.—Dimensions of pumps, ram, &c., 71.—Experiments on power required in shearing, 72.—Experiments on punching and shearing, 73.—Inclined cutters more effective than parallel cutters, 74.

*Discussion.*—Cowper, E. A., 76, 77.—Fernie, J., 75.—Jones, E., 74, 76.—Little, C., 76.—Lloyd, Samuel, 76.—Maudslay, H., 76, 77.—Muntz, G. F., 75.

HYDRAULIC SHEARS AND PUNCH, *Paper* on a hydraulic shears and punch, by J. Tangye, 1862, 341.—Description of shears, 341.—Mode of lowering shear blade after cut, 342.—Hydraulic punch, 343.—Hydraulic lifting-jack, 343.—Mode of lowering jack, 344.

*Discussion.*—Beyer, C. F., 345, 346, 347.—Joy, D., 346.—Miller, G. M., 345, 346, 347.—Tangye, J., 345, 346, 347.

HYDRAULIC STARTING APPARATUS. *See* Starting Apparatus, 1848, Apl., 12.

HYDRAULIC SWING BRIDGE. *See* Bridge, Hydraulic Swing, 1869, 121.

## I.

IKIN, J. D., elected Member, 1850, Jan., 5.

IMRAY'S FRICTION BREAK. *See* Dynamometer, 1858, 107, 113.

INDIAN RAILWAY BRIDGES. *See* Bridges, 1861, 171.

INDIAN RAILWAY BRIDGE PIERS. *See* Bridge Piers, 1863, 16.

INDIA-RUBBER COVERING MACHINE, *Paper* on a machine for covering telegraph wires with india-rubber, by C. W. Siemens, 1860, 137.—Construction of submarine telegraph cable, 137.—Conductivity of copper, 137.—Non-conducting and inductive power of various insulators, 138.—Former process for covering wires with india-rubber united by heat, 139.—New process, fresh-cut surfaces united by pressure without heat, 140.—Description of machine, 140.—Outer sheathing for submarine cables, 142.

*Discussion.*—Cowper, E. A., 146.—Fenton, J., 146.—Siemens, C. W., 143, 146.

INDIA-RUBBER PIPE JOINTS, *Paper* on Brockedon's application of vulcanised india-rubber to pipe joints, by E. A. Cowper, (extracts from Wicksteed's report), 1848, Oct., 20.—Particulars of experiments on joints with different thicknesses of india-rubber rings, 20.—Results of working, 21.—Proportions for sockets of pipes, 21.—Comparative cost of india-rubber and ordinary lead or wood joints, 21.

*Discussion.*—Clift, J. E., 22.—Cowper, E. A., 22.—Fothergill, B., 22, 23.—Humphrys, E., 22.—McConnell, J. E., 23.—Richards, T., 22, 23.

INDICATOR, CONTINUOUS, *Paper* on Ashton and Storey's steam-power meter and continuous indicator, by J. H. Storey, 1871, 75.—Advantages over ordinary intermittent indicator, 75.—Description of continuous indicator, 76.—Different modes of driving the disc and integrating wheel, 76.—Action of continuous indicator, 77.—Mode of measuring power by the meter, 78.—Indicator can be made single-acting, 79.—Effect of "cushioning" on the reading of meter, 80.—Mode of taking diagrams, 80.—Applications of indicator, 81.—Particulars of application to a pumping engine, and valuable results obtained, 81.—Application to steamships, 83.



## INDICATOR, CONTINUOUS (continued).

*Discussion.*—Alexander, A., 90.—Ashton, 85, 86, 87, 88, 90.—Cowper, E. A., 86, 89, 90.—Fenby, J. B., 87.—Hughes, G. D., 88.—Marten, E. B., 89.—Ramsbottom, J., 85, 86, 90.—Robinson, J., 86.

INGLEBY BREAK DRUMS. *See* Break Drums, 1871, 200.

INGLIS, W., elected Member, 1867, 18.

Valve Gear, *Paper* on the Corliss expansion valve-gear for stationary engines, 1868, 177.—Economy in consumption of fuel, 191.—Arrangement for starting engine, 192.—Very small clearance, 193.

INJECTOR, *Paper* on Giffard's injector for feeding steam boilers, by J. Robinson, 1860, 39.—Description of injector, 39.—Action of injector, 40.—Working of injector on locomotives, 41.—Sizes of injector, 42.—Experiments and results, 43.—Tables of results of experiments, 44.—Calculation of size of injector required for given work, 46.—Theory of action of injector, 46.

*Discussion.*—Bramwell, F. J., 48, 49, 50.—Cowper, E. A., 48.—Johnson, W. B., 48.—Kennedy, J., 51.—Markham, C., 49.—Marshall, W. P., 51.—Maudslay, H., 51.—Robinson, J., 48, 49, 50, 51.—Siemens, C. W., 48.

INJECTOR, *Supplementary Paper* on Giffard's injector for feeding steam boilers, by J. Robinson, 1860, 74.—Tables of further experiments, 75, 76.

*Discussion.*—Batho, W. F., 81.—Cowper, E. A., 80.—Ferne, J., 79, 82.—Robinson, J., 77, 79, 80, 81, 82.—Siemens, C. W., 78.

INJECTOR, SELF-ADJUSTING, *Paper* on Sellers' self-adjusting injector and other improvements on Giffard's injector, by J. Robinson, 1866, 266.—Description of construction, 266.—Mode of working, 267.—Self-starting arrangement, 268.—Improved ordinary injector, 269.—Table of delivery of water, 270.—Raising supply water, 271.

*Discussion.*—Bramwell, F. J., 274.—Cowper, E. A., 278.—Hackney, W., 277.—Lloyd, Sampson, 273, 275, 276, 279.—Robinson, J., 273, 274, 275, 276, 277, 278.—Siemens, C. W., 274, 275.—Woods, H., 277.

INJECTOR, Elevator for Colliery Drainage. *See* Elevator, 1861, 220.

INMAN, C. A., elected Member, 1872, 75.

INSHAW, J., elected Member, 1857, 55.

Boiler, High-Pressure, boiler made of copper spiral tubes, 1859, 270, 271.

Pressure Gauge, *Paper* on an improved pressure gauge, 1857, 204.—Registering pressure gauge, 208.—Testing apparatus, 209.

IRELAND, W., elected Member, 1866, 103.

IRELAND'S CUPOLA, 1856, 52.

IRON ARMOUR for Ships. *See* Armour, 1861, 121.—1862, 289.

IRON, BLOOMING MACHINE, *Paper* on a new machine for blooming iron, by J. Beasley, 1851, Apl., 36.—Description of machine, 37.—Action of rolls, 37.

## IRON, BLOOMING MACHINE (continued).

—Provision against breakage, 38.—Saving of time and expense, 38.—Saving of power, and improved quality of iron, 40.

*Discussion.*—Beasley, J., 41, 43, 44.—Cowper, E. A., 41, 43, 45.—Gibbons, B., 42.—Hodgkinson, E., 45.—McConnell, J. E., 43, 45.—Siemens, C. W., 42, 44.—Slate, A., 44.—Walker, T., 43, 44.—Williams, R., 43, 44.

IRON, BLOOMING MACHINE, *Supplementary Paper* on a new machine for blooming iron, by J. Beasley, 1851, June, 3.—Rate of production of blooms, 5.—Cost of wear and tear, 6.—Diagrams showing saving of power over hammer, 7.—Power required to drive blooming machine and rolls, and hammer and rolls, 9.—Improved quality of iron, 10.

*Discussion.*—Adams, W. A., 12, 13.—Beasley, J., 11, 12, 13, 14, 15.—Blackwell, S. H., 12, 15.—Cowper, E. A., 13.—Hodge, P. R., 14, 15.—Hodgkinson, E., 14.—McConnell, J. E., 11, 14, 15.—Moorsom, W. S., 15.—Russell, J. S., 15.

IRON COLUMNS, Removal, *Paper* on the removing and replacing of the iron columns in a cotton mill, by W. Fairbairn, 1866, 181.—Increased size of mules necessitating alteration in mills, 181.—Arrangement of mill, 182.—Construction of new columns, 183.—Cutting apparatus, 184.

*Discussion.*—Fairbairn, W., 185.—Whitworth, J., 185.

IRON CONSTRUCTION OF FOUNDRY. *See* Foundry, 1856, 165.

IRON, ELASTICITY OF, elastic stretching of lifting bars for Britannia tubular bridge, 1849, Oct., 25.

IRON LIGHTHOUSE. *See* Lighthouse, 1861, 15.

IRON MANUFACTURE, *Paper* on iron, and some improvements in its manufacture, by J. D. M. Stirling, 1853, 19.—Deficiency of knowledge of chemical properties of iron, 19.—General process of iron smelting, 20.—Experiments on cast-iron and new toughened cast-iron, 22.—Applications of toughened cast-iron, 23.—Refining and puddling, 24.—Alloys of iron and other metals, 25.—Wrought-iron alloyed with tin, 26.—Experiments on toughened wrought-iron and ordinary wrought-iron, 27.

*Discussion.*—Adams, W. A., 30.—Beasley, J., 29, 30.—Cowper, E. A., 32.—Duclos de Boussois, E., 28.—Fairbairn, T., 30.—McConnell, J. E., 29, 31.—Slaughter, E., 32, 33.—Stephenson, R., 28, 33.—Stirling, J. D. M., 28, 29, 30, 31, 32, 33.—Williams, R., 31.

IRON MANUFACTURE, Hæmatite, *Paper* on the manufacture of hæmatite iron, by W. Crossley, 1871, 118.—Size of furnaces at Barrow and Askam, 118.—Dimensions of furnaces, 119.—Taking off waste gases, 119.—Large furnace at Askam, 120.—Furnace top, closed and semi-closed, 120.—Ores &c. used, 121.—Analysis of Askam ore, 121.—Analyses of aluminous

## IRON MANUFACTURE (continued).

iron ores, 122.—Stainton limestone, 124.—Durham coke, 125.—Importance of proper distribution of materials in furnace, 125.—Improved form of tuyere and tuyere-breast, 125.—Results of working of Askam furnaces, 126.—Analyses of escaping gases, 126.—Hæmatite pig, 127.—Slag, 128.—Consumption of coke, 128.—Appendix, 129.—Ultimate composition of escaping gases, 130.—Weight and composition of escaping gases, 131.—Weight of blast supplied per ton of pig, 131.—Tables of amounts of heat produced, absorbed, and lost, 133, 134.

*Discussion.*—Adamson, D., 140, 142.—Barton, E., 138.—Bell, I. L., 143.—Clay, W., 135, 143.—Cochrane, C., 135.—Crossley, W., 136, 139, 145.—Pease, J. B., 141.—Ramsbottom, J., 136, 145.—Whitwell, T., 137.

IRON MANUFACTURE in Cleveland District. *See* Blast Furnaces, 1864, 249.

IRON MINING, South Yorkshire. *See* Coal Mining, 1862, 68.

IRON PUDDLING by Machinery. *See* Puddling Machine, 1864, 298.—1867, 151.

IRON SHIPS, Construction. *See* Ships, Iron, 1863, 115.

IRON WAR SHIPS. *See* Ships, Iron, 1856, 221.

IRON, WROUGHT, rendered brittle by repeated jarring when cold, without any blow being struck, 1850, Jan., 17.

IRONSTONE SEAMS in Glasgow Coalfield. *See* Coalfield, Glasgow, 1864, 229.

IRONWORKS ENGINES. *See* Dowlais Ironworks Engines, 1857, 112.

IRONWORKS, GROSMONT, *Paper* on the new ironworks at Grosmont, by H. C. Coulthard, 1863, 225.—Position of works, 225.—Dimensions of blast furnaces, 226.—Furnace top, 227.—Hot-blast stoves, 227.—Blowing engines, 228.—Boilers, 229.

*Discussion.*—Adamson, D., 231, 233, 236, 240.—Bastow, S., 239.—Bramwell, F. J., 231, 233, 240.—Clay, W., 241.—Ferne, J., 234, 236.—Lloyd, Sampson, 229, 235, 241.—Plum, T. W., 230, 233.—Reynolds, E., 231.—Richardson, W., 237, 239.—Smith, I., 237.

IRONWORKS, ROUND-OAK, *Paper* on the Round-Oak Ironworks, by F. Smith, 1860, 211.—Description of forge, 211.—Rolls and hammers, 212.—Plate and bar rolls, 213.—Circular saw, bar and guide mills, 214.—Wire mill, 215.—Puddling furnaces, 215.—Balling and heating furnaces; dimensions of furnaces, 216.—Railway and canal arrangements, &c., 216.—Series of processes for production of different qualities of iron, 217.—Waste of iron, and consumption of coal, 218.

*Discussion.*—Adams, W. A., 220.—Cochrane, A. B., 219, 221.—Dunn, T., 221.—Hall, W., 221.—Kennedy, J., 222.—Lloyd, Sampson, 219.—Lloyd, Samuel, 221.—Pilkington, R., 221.—Smith, F., 221, 222.—Smith, R., 220.

JACK, A., elected Member, 1872, 75.

JACK, J., Surface Condensers, *Paper* on the effects of surface condensers on steam boilers, 1863, 150.

JACK, HYDRAULIC LIFTING. *See* Hydraulic Shears and Punch, 1862, 343.

JACKSON, J., elected Member, 1865, 53.

JACKSON, J. P., elected Member, 1870, 19.

JACKSON, M. M., elected Member, 1859, 247.

JACKSON, P. R., Original Member, 1847.

Moulding Machine, *Paper* on a new moulding machine for cog and other wheels, 1855, 41.—Cutter for shaping pattern, 50.—Moulding bevil wheels, 50.—Cost of wheels, 51.—Tracing epicycloidal teeth, 52.—Time of moulding, 52.—High speed of running practicable with accurately moulded wheels, 54.—Moulding sand, 56.

Piston Packing, durability of improved curved rings, 1855, 207.

Starting Apparatus, *Paper* on a hydraulic starting apparatus, 1848, Apl., 12.

—Conical clutch not able to drive same power as hydraulic apparatus, 12.

JACKSON, R., elected Member, 1861, 109.

JACKSON, S. (Sheffield), elected Member, 1860, 53.

JACKSON, S. (Bombay), elected Member, 1873, 45.

JACKSON, W. F., elected Member, 1872, 75.

JACOB, E. W., elected Member, 1873, 25.

JAEGER, H. F., elected Member, 1866, 264.

JAFFRAY, J., Type-Setting Machine, not suitable for newspapers, 1863, 54.

JAFFREY, G. W., elected Member, 1858, 266.

JAMES, JABEZ, elected Member, 1856, 250.

JAMES, JOHN, elected Member, 1868, 103.

JAMIESON, J. L. K., elected Member, 1870, 19.

Marine Engines, great improvement in modern compound engines, 1872, 163.

—Important to reduce consumption of fuel further, 164.—Effect of steam-jacketing cylinders, 172.—Important advantages from high-pressure steam, 173.

JARVIS, E. G., elected Member, 1865, 102.

JEE, A. S., elected Member, 1848, July, 20.—Decease, 1859, 2.

JEFFCOCK, P., elected Member, 1855, 97.—Decease, 1867, 2.—Memoir, 15.

Coal Mining, South Yorkshire, *Paper* on the coal and iron mining of South Yorkshire, 1862, 68.—Difficulty of ventilating "bank work," advantage of "long wall," 80.—Length of long-wall face, 81.—Cost of long-wall getting, 82.—Getting "deep" coal; pumps, 83.—Cast-iron puncheons, 84.—Cost of timbering, 85.—Safety lamps do not interfere with rate of working, 86.

JEFFCOCK, T. W., elected Member, 1861, 109.

JEFFREYS, E. A., elected Member, 1856, 79.—Re-elected, 1863, 113.

JENKIN, F., Telegraph Cables, *Paper* on the construction of submarine telegraph cables, 1862, 211.—Failure of cable nearly always due to fracture of copper conductor, 239.—Action of currents on insulating materials, 240.

JENKINS, W., elected Member, 1857, 201.—Decease, 1868, 2.—Memoir, 16.

JENSEN, P., Marine Engine Governor, *Paper* on a marine engine governor, 1859, 92.

JESSOP, S., elected Member, 1861, 53.

JESSOP, T., elected Member, 1861, 53.

JOBSON, J., elected Member, 1854, 79.

JOBSON, R., elected Member, 1847.—Re-elected, 1868, 43.—Decease, 1873, 2.—Memoir, 19.

Casting Moulds, *Paper* on an improved construction of moulds for casting metals, 1854, 62.—Cost of dressing ordinary castings, 69.—Sulphur face for ramming block, 69.

Moulding and Casting, *Paper* on an improved system of moulding and casting, 1858, 14.—Cost of machine for moulding railway chairs, 20.

JOHNS, H., elected Member, 1851, Oct., 28.

JOHNSON, B., elected Member, 1863, 113.

JOHNSON, H. S., elected Member, 1847.

JOHNSON, J., elected Member, 1847.

JOHNSON, R. W., elected Member, 1848, Apl., 23.—Re-elected, 1854, 49.

JOHNSON, S. W., elected Member, 1861, 211.

JOHNSON, T. M., elected Member, 1847.

JOHNSON, W., elected Member, 1849, Oct., 32.

JOHNSON, W. B., elected Member, 1855, 6.

Boiler, evaporative duty, 1854, 130.—Short tubes more efficient than long, 132.

Evaporating Power of Tubes, no practical difference between brass and iron tubes, 1857, 122.

Smoke Prevention, *Paper* on an apparatus for the prevention of smoke in steam boiler and other furnaces, 1857, 125.

Steam Engine, *Paper* on an improved horizontal condensing steam engine, 1855, 198.—Steam-jacket not of much value, 203.

JOHNSTONE, J., elected Honorary Member, 1848.

Sugar Evaporator, sugar clarified by exposure to air, 1856, 182.—Injurious effect of custom laws, 183.

JOICEY, J. G., elected Member, 1872, 254.

JOINT for Pipes, to stand high temperature, 1873, 82.—For hydraulic machinery, 1858, 143.—1872, 201.

JONES, A., elected Member, 1861, 14.

JONES, C., elected Member, 1872, 75.

JONES, C. H., elected Member, 1871, 262.



JONES, D., elected Member, 1861, 53.

JONES, E. (Bridgewater), Original Member, 1847.—Council, 1849, Jan., 9.  
—1851, Jan., 8.—Vice-President, 1854, 5.—Council, 1856, 6.—Vice-President, 1859, 13.—Council, 1862, 19.—1865, 19.

Brick-Making Machine, *Paper* on the American dry-clay brick-making machine, 1853, 148.

Crossing, spring crossing very successful, 1852, 218.—Steel spring better than india-rubber, 218.

Hydraulic Shearing Press, experiments on force required to punch different sized holes in different thicknesses of plate, 1858, 76.

JONES, E. (Birmingham), elected Member, 1873, 25.

JONES, E. F., Blast-Furnace Materials, good results from use of raw ironstone, 1871, 169, 170.

JONES, E. T., elected Member, 1873, 88.

JONES, G. E., elected Graduate, 1867, 19.

JONES, J., (Bristol), elected Member, 1848.

Cambrian Engine, *Paper* on the adaptation of the Cambrian engine to locomotive purposes, 1848, Oct., 13.

JONES, J., (Middlesbrough), elected Associate, 1869, 277.

Cleveland Iron District, *Paper* on the general geological features of the Cleveland iron district, 1871, 184.—Origin of deposits of salt and ironstone not clearly known, 198.—Ironstone seams lie nearly horizontal, 198.

JONES, J., (Newton), elected Member, 1847.

JONES, J. G., Coal-Cutting Machine, cutting out a wedge of coal at bottom of thick seams, 1864, 289.

JONES, J. H., elected Member, 1857, 55.

JONES, W. R. S., elected Member, 1872, 75.

JOULE, J. P., Surface Condenser, *Paper* on a surface condenser, 1856, 185.

Joy, D., elected Member, 1853, 45.

Feed-Pipe Connexion, cost of hose-pipe connexion, 1862, 91.—Coiled-tube connexion very successful, 91.

Hydraulic Engine, *Paper* on a new hydraulic engine, 1857, 184.—Regulating speed of valve for different pressures, 186.—Self-regulating action of engine, 187.

Piston Packing, *Paper* on a spiral-coil piston-packing, 1855, 171.—Durability of packing rings, 175.

Rivet-Making Machine, great durability and absence of wear in the machine, 1861, 216.—Manufacture of the cast-iron dies, 217.—Experiments on action of machine, 218.—Rate of making rivets of different sizes, 219.

Safety Valve, increase of pressure while blowing off, 1855, 135.

JUMNA RAILWAY BRIDGE, Foundation for Piers. *See* Railway Bridge Piers, 1863, 16.

KAY, J. C., elected Member, 1857, 201.

Safety Valves, *Paper* on an improved construction of safety valves for steam boilers, 1857, 211.—Low-water valve independent of steam pressure, 215.—Cost, 216.—Tendency to prime on sudden opening of valve, 216.

KEEN, A., elected Member, 1869, 77.

KEEP, A., elected Member, 1869, 77.

KELLETT, J., elected Member, 1867, 59.

KELSON, F. C., elected Member, 1873, 250.

KENDALL, W., elected Member, 1857, 55.

KENNAN, J., elected Member, 1863, 15.

KENNEDY, J., elected Member, 1847.—President, 1860, 13.

KENNEDY, J. P., Lt.-Col., elected Member, 1857, 232.

Indian Railway Bridges, *Paper* on the construction and erection of iron piers and superstructures for railway bridges in alluvial districts, 1861, 171.—Peculiar requirements of Indian railways, 182.—Mode of screwing in piles, 183.—Diagonal bracing between piles distributes load over all, 184.—Each span of bridge quite separate, 188.—Expansion of spans, 188.—Painting to protect iron from corrosion, 189.—Adjustment of level of tops of piles, 191.—Difficulty from broken piles, 191.

KENNEDY, J. P., elected Member, 1863, 57.

KENNEDY, T., Water Meter, *Paper* on an improved water meter, 1856, 151.—Pressure required to work meter, 157.—Cost of repairs very small, 157.

KENNEDY, T. S., elected Member, 1868, 20.

KERR, P., elected Member, 1868, 103.—Decease, 1870, 2.—Memoir, 14.

KERSHAW, J., elected Member, 1866, 17.

KESTERTON, H., Boilers, Root boiler very successful for marine purposes, 1871, 246.

KIMBALL, F. J., elected Member, 1867, 234.

KIND'S SYSTEM OF BORING. *See* Boring, 1854, 87.

KINDER, T. W., elected Member, 1848, Apl., 23.

KING, W., elected Member, 1872, 254.

KINMOND, W. L., elected Member, 1848, Apl., 23. — Re-elected, 1852, 153.

Railway Carriage Elevator, *Paper* on a railway carriage elevator, 1848, Oct., 17.

KINSEY, H., elected Member, 1870, 125.

KIRK, A. C., elected Member, 1872, 119.

KIRKALDY, D., elected Member, 1865, 20.

KIRKHAM, J., elected Member, 1848, July, 20.

KIRKLESS HALL Iron Works, Blake Stone-Breaking Machine. *See* Stone-Breaking Machine, 1864, 20.

KIRTLEY, M., Original Member, 1847.—Council, 1852, 8.—1855, 5.

KIRTLEY, W., elected Member, 1864, 271.

Boilers, Corrosion of, *Paper* on the corrosion of locomotive boilers and the means of prevention, 1866, 56.

Counter-pressure Steam Break, trials on Lickey incline of Midland Railway, 1870, 47.

Riveted Joints, thickened edges for transverse seams, and welded longitudinal joints in locomotive boilers, 1872, 83.

KITSON, F. W., elected Member, 1859, 53.—Member of Council, 1870, 18.—1872, 25.

Governor, *Paper* on the Allen governor and throttle-valve for steam engines, 1873, 47.

KITSON, J., elected Member, 1848, July, 20.—Council, 1855, 5.—1858, 12.—1861, 13.—1863, 14.

Gas Lighting for Trains, *Paper* on lighting railway trains with gas, with description of T. J. Thompson's system, 1857, 242.

Hammer, *Paper* on an improved friction hammer, 1854, 133.

KITSON, J., Jun., elected Member, 1859, 53.

KITSON, J. H., elected Member, 1868, 103.

KNAP, C., elected Member, 1866, 17.

KNIGHT, G., elected Honorary Member, 1854, 49.

KNIGHT, S. J., elected Member, 1848, Apl., 23.

KNIGHT, T., elected Member, 1863, 15.

KNITTING MACHINE, *Paper* on self-acting machinery for knitting hosiery by power, by A. Paget, 1870, 127.—Nature of knitted web, 127.—Self-acting knitting machine, 128.—Knitting, 128.—Narrowing, 130.—Means by which movements of primary parts are effected, 133.—“Drawing across” the thread tube, 133.—Movements of the “sinkers,” 135.—Motion of needles, 136.—Movements for narrowing, 136.—Pitch-chains to regulate shape of article, 137.—Arrangement of cams to effect different motions, 138.—Rate of knitting, 139.

*Discussion*.—Bramwell, F. J., 142.—Chapman, H., 140.—Hawksley, C., 144.—Hawksley, T., 140, 141, 145.—Head, J., 143.—Paget, A., 140, 141, 143, 144.

KNOTT, J., elected Member, 1862, 93.

KOE, S. L., elected Member, 1869, 276.

KOHN, F., elected Member, 1869, 20.—Decease, 1872, 2.—Memoir, 19.

KRIGAR'S CUPOLA, 1868, 89.

LACKENBY BLOWING ENGINES. *See* Blowing Engines, 1871, 175.—1872, 274.

LAIRD, H. H., elected Member, 1872, 254.

LAIRD, W., elected Member, 1872, 119.

Marine Engines, saving of coal in compound engines, 1872, 178.—Low pressure of steam not desirable, 178.

LAMB, A., elected Member, 1847.

Boiler, *Paper* on an improved boiler for marine engines, 1852, 9.

LAMB, W. J., elected Member, 1873, 25.

LAMBERT, W. B., elected Member, 1866, 264.

LAMP, SAFETY. *See* Safety Lamp, 1851, Oct., 23.

LANCASTER, C. W., elected Member, 1867, 18.

LANCASTER, JOHN, elected Member, 1863, 57.

Stone-Breaking Machine, Blake's, *Paper* on a machine for breaking limestone and ore at Kirkless Hall Iron Works, 1864, 20.—Cheaper than hand labour for breaking limestone, 28.

Well Boring, cost of boring in Nottinghamshire and Lancashire, 1867, 184.

—Kind's annular tool, 184.

LANCASTER, JOSHUA, elected Member, 1870, 228.

LANGDON, W., Original Member, 1847.

LATHAM, E., elected Member, 1863, 15.

LAURENT, F., elected Member, 1858, 80.—Decease, 1860, 2.

Ventilating Machine, Lemielle's, particulars of largest machine yet erected, 1858, 69.—Degree of vacuum, 69.

LAW, D., elected Member, 1860, 14.—Decease, 1870, 2.—Memoir, 15.

LAWRENCE, H., elected Member, 1867, 59.

Coal-Cutting Machinery, adoption of hydraulic machines in Northumberland, 1868, 159.—Value of machines for thin seams, 159.

LAWRIE, J. G., elected Member, 1847.

LAWSON, E., elected Member, 1848, Apl., 23.

LAWTON, B. C., elected Honorary Member, 1858, 266.

LAYBORN, D., elected Member, 1870, 228.

LAYBOURNE, J., elected Member, 1857, 232.—Decease, 1873, 2.—Memoir, 18.

Boiler, Cast-Iron, *Paper* on Miller's cast-iron steam boiler, 1871, 263.—

Space occupied by boiler, cost, &c., 276.—Freedom from incrustation, 277.—Application to puddling furnace, 280.

LAYBOURNE, R., elected Member, 1856, 79.

Coal-Burning Locomotive, trials of Welsh coal and coke, 1858, 287.—

Jeffreys' grate for burning coal, 292.

LEA, H., elected Member, 1860, 89.

LEA, J. (Bowling), elected Member, 1868, 103.

LEA, J. (London), Axlebox, new lubricating material for axleboxes, 1852, 217.

Lubrication, *Paper* on a new lubricating material, 1853, 65.—Cost of lubricating material, 68.

LEAHY, E., Original Member, 1847.

LEAHY, M., Original Member, 1847.

LEAN, T., Engines, Portable, for Mining, economy of fuel very important in Cornwall, 1873, 183.—Best Cornish engines not reported, 189.—Falling-off in duty of Cornish engines of late years, 190.—Slow combustion impracticable with bad coal, 190.—Highest piston-speed of Cornish engines, 198.—Table of duty of Cornish pumping engines from 1811 to 1872, 200, 201.

LEATHER, J., elected Member, 1848, July, 20.

LEATHER, J. T., elected Honorary Member, 1859, 54.

LE CHATELIER Steam Break. *See* Counter-pressure Steam Break, 1870, 21.

LEDGER, J., elected Member, 1865, 53.

LEDGER, T., elected Member, 1852, 153.

LEE, J., elected Member, 1860, 89.

LEE, J. C. F., elected Member, 1862, 47.

LEE, W. (Cheltenham), Original Honorary Member, 1847.

LEE, W. (Tipton), elected Member, 1871, 262.

LEE'S RAILWAY BREAK. *See* Break, Railway, 1852, 20.

LEEDS Summer Meetings, 1859, 133.—1868, 103.

LEES, J., elected Member, 1857, 11.—Decease, 1862, 3.—Memoir, 17.

LEES, S., elected Member, 1857, 201.

LEES, S., Jun., elected Member, 1863, 57.

LEESE, Fuel Economiser, saving in consumption of fuel, 1857, 198.—  
Examination and cleansing, 199.

LEIGH, E., elected Member, 1863, 113.

LEIGH, F. A., elected Member, 1865, 53.

LEIGH, J., elected Member, 1866, 264.

LEMIELLE'S VENTILATING MACHINE. *See* Ventilating Machine, 1858, 63.

LENZ, A., Uchatius Cast Steel, some impurity advisable in steel, 1858, 152.—  
Description of Chenot's process, 153.

LEONARD, E. J., elected Member, 1870, 19.

LESLIE, A., elected Member, 1858, 266.

LESLIE, B., elected Member, 1872, 119.

LEVI, L., Decimal Measure, Inch and Metre, importance of uniform international system of weights and measures, 1865, 48.—Thorough efficiency of metre system for English requirements, 49.

LEVICK, F., elected Member, 1856, 250.—Decease, 1868, 2.—Memoir, 17.

Coal-Cutting Machine, holing very thick coal, 1864, 284.—Working inclined seams, 287.—Cost of machine, 291.

LEVICK, T., Coal-Cutting Machine (Jones'), *Paper* on a coal-cutting machine, 1864, 272.—Holing done in three cuts, 289.—Driving headings, 290.—Air pipes, 291.—Undercutting hard coal, 295.



LEWIS, B., elected Member, 1848, Apl., 23.

LEWIS, R. A., elected Member, 1872, 26.

LEWIS, R. W., elected Member, 1872, 75.

LEWIS, T. W., elected Member, 1860, 250.

LIBRARY, Donations to, 1850, Jan., 39.—1851, Jan., 4.—1852, 4.—1853, 4.—1854, 2.—1855, 2.—1856, 2.—1857, 2, 202.—1858, 2.—1859, 2.—1860, 2.—1861, 2.—1862, 3.—1863, 2.—1864, 2.—1865, 2.—1866, 2.—1867, 2.—1868, 2.—1869, 2.—1870, 2.—1871, 2.—1872, 2.—1873, 2.

LICKEY INCLINE on Midland Railway, working of, 1863, 111.

LIFT, PNEUMATIC. *See* Pneumatic Lift, 1849, July, 11.

LIFTING JACK, HYDRAULIC. *See* Hydraulic Shears and Punch, 1862, 343.

LIFTING MACHINE, *Paper* on a new portable lifting machine, by J. E. McConnell, 1852, 88.—Description of machine, 88.—Power gained, 89.—Application of plan to vice and rack-pulley, 90.

*Discussion*.—McConnell, J. E., 90.

LIGHTHOUSE APPARATUS, *Paper* on the construction of lighting apparatus for lighthouses, by A. Masselin, 1862, 48.—Early lighthouses, 48.—Dioptric lights, 49.—Table of "orders" of dioptric lights, 50.—Catoptric lights, 51.—Comparison of the two systems, 51.—Lamps, 53.—Chimney, oil, wicks, &c., 56.—Description of revolving dioptric apparatus, 57.—Lantern, 58.—Divergence of rays, 59.

*Discussion*.—Cochrane, A. B., 61, 62, 63, 65, 66, 67.—Lloyd, Sampson, 64.—Masselin, A., 61, 62, 63, 64, 65, 66.—Mathews, W., Jun., 66.

LIGHTHOUSE, WROUGHT-IRON, *Paper* on the Buda wrought-iron lighthouse, by J. H. Porter, 1861, 15.—Position of lighthouse, 15.—Construction of lighthouse, 16.—Screw piles, 17.—Girders at base, 18.—Main pillars, 19.—Attachments of girders and framing, 21.—Dwelling-house, 22.—Lighting apparatus, 23.

*Discussion*.—Bramwell, F. J., 28, 29.—Cochrane, J., 27.—Cowper, E. A., 26.—Fenton, J., 25.—Ferne, J., 29.—Fothergill, B., 29.—Markham, C., 28.—Masselin, A., 27.—Porter, J. H., 25, 27, 29.

LIGHTING RAILWAY TRAINS with Gas. *See* Gas Lighting for Trains, 1857, 242.

LIMESTONE SEAMS in Glasgow Coalfield. *See* Coalfield, Glasgow, 1864, 229.

LINDAL COTE JUNCTION, locking apparatus for signals and points, 1873, 36.

LINDSLEY, G., elected Member, 1864, 271.

LINK MOTION, *Paper* on an improved construction of link motion for locomotive and other engines, by A. Allan, 1856, 70.—Ordinary stationary and shifting links, 70.—Description of straight link, 71.—Lead preserved almost uniform, 72.—Diagrams from straight link, 72.—Description of improved form of link, 73.—Other forms, 73.—Tables of distribution of steam, 74.—Reversing rack, 76.

*Discussion*.—Fenton, J., 76, 77.—Ferne, J., 76.—Fothergill, B., 76, 77.

LINN, A. G., elected Member, 1856, 79.

LINN, J., elected Member, 1850, Jan., 5.

LINSLEY, S. W., elected Member, 1872, 254.

LITTLE, C., elected Member, 1857, 11.

Hydraulic Shearing Press, *Paper* on a hydraulic shearing press, 1858, 70.—

Cost of shearing machine, 76.

LITTLE, G., elected Member, 1866, 264.

LITTLE, J., Scraper for Torquay Water Works, *Paper* on the mechanical scraper for removing incrustation in the mains of the Torquay Water Works, 1873, 216.

LIVERPOOL DOCKS, Machinery for Warehousing Grain. *See* Corn-Warehousing Machinery, 1869, 208.

LIVERPOOL Summer Meetings, 1863, 113.—1872, 119.

LIVERPOOL TUNNEL, Ventilating Fan. *See* Ventilating Fan, 1871, 22, 66.

LIVERPOOL WATER WORKS. *See* Water Works, Liverpool, 1863, 167.

LIVESEY, J., elected Member, 1867, 234.

LLEWELLYN, W. H., elected Member, 1873, 88.

LLOYD, C., elected Member, 1867, 59.

LLOYD, E. R., elected Member, 1863, 113.

LLOYD, F. H., elected Member, 1871, 117.

LLOYD, G., Regenerative Gas Furnace, highly satisfactory for flint-glass furnaces, 1862, 38.—Saving in fuel, 39.—Durability of furnace, 39.

LLOYD, G. B., elected Member, 1854, 5.

LLOYD, J., elected Member, 1862, 93.

LLOYD, J. F., elected Member, 1866, 55.

LLOYD, SAMPSON, Original Member, 1847.—Council, 1854, 5.—1857, 11.—1860, 13.—1863, 14.—Vice-President, 1864, 18.—1865, 19.—1866, 16.—1867, 17.—1868, 19.—1869, 19.—1870, 18.—1871, 20.—1872, 25.—Council, 1873, 24.

Boiler Lining, use of collecting pans to catch deposit, 1871, 57.

Disintegrator, at Swansea used for pulverising coal and calamine, 1872, 48.—Beaters apt to break, causing others to break also, 48.

Friction Hammer, wood facing to friction lifting rollers, 1854, 136.

Hot-Blast Ovens, introduction of hot blast into Staffordshire, 1859, 87.—Great increase of yield of same-sized blast furnaces after introduction of hot blast, 88.

Iron Works, extremity of gas tube in throat of blast furnace usually of cast iron, 1863, 230.—Large slow-working blowing engine is best, 230.—In some blast furnaces best to take off only portion of gas, 235.

Nasmyth's Girders, *Paper* on Nasmyth's girders and fire-proof floors, 1849, Oct., 27.—Cast iron bears greater compression, but wrought iron facilitates distribution of pressure, 31.

LLOYD, SAMPSON (continued).

Pumping Engine, wrought-iron beam composed of plates riveted together, 1863, 266.

Water Axlebox, *Paper* on Aerts' water axlebox, 1860, 178.—Successful application to heavy shafting, 182.

LLOYD, SAMUEL, Jun., elected Member, 1852, 191.

Blast-Furnace Gas, *Paper* on taking off the waste gas from open-topped blast furnaces, 1860, 251.—Gases taken off successfully with open-topped furnace in South Staffordshire, 129.—Dust from furnace caught in gas tube, 271.—Slightly increased yield in puddling iron from furnace with gas taken off, 272.—Variation in quantity of gas given off, 272.—Sticking of valves in gas main from accumulation of pitch, 275.—Central tube for waste gas in open-topped furnace, 1869, 38.

Turntable, *Paper* on an improved turntable, 1853, 126.

Ventilating Machine, *Paper* on Lemielle's ventilating machine for mines, 1858, 63.—Cost of machine, 67.

LLOYD, S. Z., elected Member, 1864, 121.

LLOYD, W., elected Member, 1862, 47.

LLOYD'S BLOWING FAN. *See* Hoist and Cupola, 1856, 54, 56.

LOAM, M. H., elected Member, 1863, 57.

LOCH KATRINE WATER WORKS. *See* Water Works, Glasgow, 1864, 123.

LOCKHART, H. C., elected Member, 1869, 77.

LOCKS, *Paper* on the progress of improvements in locks in the United States of America, by P. R. Hodge, 1851, June, 16.—English locks, 16.—Andrews' lock, 17.—Newell's permutating lock, 17.—Picking instruments, 19.—Description of Newell's parautoptic lock, 20.—Number of changes of tumblers, 22.—Sources of security, 22.

*Discussion.*—Appold, J. G., 27.—Chubb, J., 23, 24, 25, 26.—Geach, C., 26.—Hensman, H., 26.—Hobbs, A. C., 25, 27.—Hodge, P. R., 23, 25.—McConnell, J. E., 23, 24, 27.—Russell, J. S., 24, 25.

LOCK, *Paper* on an improved construction of lock and key, by J. B. Fenby, 1866, 79.—Fixed-guard or warded locks, 79.—Egyptian lock, 80.—Letter lock, 80.—Tumbler lock, 81.—Barron tumbler lock, 81.—Lever lock, 81.—Bramah lock, 82.—Newell's American lock, 83.—Mode of picking movable-guard locks, 85.—Improved lock and key, 88.—Key in two parts, 89.—Impossible to introduce a pick, 90.—Unlocking, 91.—Security against false keys, 93.—Key-cutting machine, 94.—Special features of improved lock, 96.

*Discussion.*—Fenby, J. B., 98, 99, 100, 101.—Longridge, W. S., 101.—Maudslay, H., 99, 100, 101, 102.

LOCK, BANK, description of, by E. Cotterill, 1852, 93.

LOCOMOTIVE, ATLAS, *Paper* on the luggage engine "Atlas," by C. F. Beyer, 1847, Nov., 3.—Description of engine, 3.—Diagrams of working of valves, 5.—Form of wear of tyres, 6.—Particulars of trial of engine, 6.—Tables of curves, gradients, and working cost, 8.

LOCOMOTIVE AXLEBOX. *See* Axlebox, 1851, Jan., 30.—1851, Apl., 3.—1852, 213.—1853, 37.

LOCOMOTIVE AXLEBOX AND COUPLING ROD. *See* Axlebox, 1858, 166.

LOCOMOTIVE BLAST-PIPE, force required to overcome resistance of tubes, 1849, Apl., 5, 10.

LOCOMOTIVE BOILER. *See* Boiler, 1849, July, 3.—1856, 233, 236.—1866, 56.

LOCOMOTIVE BOILER TUBES. *See* Boiler Tubes, 1867, 46.

LOCOMOTIVE, CAMBRIAN, *Paper* on the adaptation of the Cambrian engine to locomotive purposes, by J. Jones, 1848, Oct., 13.—Side levers receive oscillating motion from pistons, and coupled by connecting-rods to crank-pins on leading and centre wheels, 13.—Centre pressure and oscillating motion of engine avoided, 13.—Increased leverage obtained towards dead centres of crank, 13.—Long stroke of crank obtained without long stroke in cylinder, 13.

*Discussion.*—Beyer, C. F., 17.—Cowper, E. A., 14, 16, 17.—Crampton, T. R., 14, 15, 17.—Humphrys, E., 16.—Jackson, P. R., 17.—McConnell, J. E., 15, 17.—Peacock, R., 15.—Slate, A., 15, 16, 17.

LOCOMOTIVE, CARRIAGE, *Paper* on an express locomotive engine, by J. Samuel, 1848, June, 8.—Small "carriage engine" for conveying passengers on branch lines, 8.—Engine and carriage combined to reduce dead weight, 8.—Light railways at small cost could be made available for branches with small traffic, 9.

*Discussion.*—Cowper, E. A., 10.—McConnell, J. E., 10.—Samuel, J., 10.

LOCOMOTIVE, COAL-BURNING, *Paper* on an improved locomotive engine, by J. Beattie, 1854, 24.—Coal-burning locomotive, 24.—Details of trials, 25.—Description of coal firebox, 25.—Water heater, 27.—Success of working, 28.

*Discussion.*—Beattie, J., 29, 31, 32.—Clark, D. K., 31.—Cowper, E. A., 29, 30, 32.—Fairbairn, W., 29, 30, 33.—Hodge, P. R., 29, 30, 32.—Siemens, C. W., 31.—Slate, A., 29, 30.

LOCOMOTIVE, COAL-BURNING, *Paper* on the burning of Welsh steam coal in locomotive engines, by J. Tomlinson, 1858, 274.—Failure of firebars on first using coal, 274.—Layer of broken firebrick covering firebars, 275.—Experiments on commercial value of different coals and coke, 276.—Analysis of Aberdare four-foot coal, 278.—Tables of experiments on Welsh steam coal and coke, 279 to 285.

*Discussion.*—Chellingworth, T. T., 294.—Clift, J. E., 287, 290, 294.—Cowper, E. A., 293.—Craig, W. G., 290, 294.—Fenton, J., 288, 291.—

LOCOMOTIVE, COAL-BURNING (continued).

Fernie, J., 294, 295.—Fothergill, B., 288.—Laybourne, R., 287, 288, 292, 293.—Maudslay, H., 286, 288, 293, 295.—Siemens, C. W., 294.—Smith, W., 291.—Tomlinson, J., 286, 287, 288, 290, 292, 293, 294.

LOCOMOTIVE, COAL-BURNING, *Paper* on the burning of coal instead of coke in locomotive engines, by C. Markham, 1860, 147.—Early attempts at coal-burning, 148.—Requirements for complete combustion of coal, 150.—Experiments on Midland Railway with air tubes, brick arch, and deflecting plate, 151.—Very long deflecting plate great improvement, 153.—Deflecting plate for fireboxes with midfeather, 154.—Double-sliding firedoors, 155.—Improved firebrick arch, 156.—Steam jet to consume smoke when engine standing, 157.—Firebars, 157.—Table of experiments on evaporative power of cokes and coals, 159.—Saving from use of coal instead of coke, 161.—Cost of altering locomotive to burn coal, 162.—Tables of evaporative power of various cokes and coals, 164 to 171.

*Discussion.*—Adamson, D., 174.—Cowper, E. A., 176.—Fenton, J., 173, 176.—Fothergill, B., 172, 175.—Markham, C., 173, 175.—Wrigley, F., 172.

LOCOMOTIVE, CUGNOT, *Paper* on Cugnot's original invention of the locomotive steam engine for common roads, by E. A. Cowper, 1853, 33.—History of Cugnot's engine, 34.—Description, 35.—Driving ratchets, 35.—Steering gear, 36.

*Discussion.*—Stephenson, R., 37.

LOCOMOTIVES, DISTRIBUTION OF WEIGHT, *Paper* on the distribution of weight on the axles of locomotives, by J. Robinson, 1864, 92.—Main conditions influencing position of axles, 92.—Four-wheeled engines, 93.—Six-wheeled uncoupled passenger engines, 94.—Coupled passenger engines, 97.—Engines with four front wheels coupled, 99.—Six-coupled engines, 101.—Bogie engines, 104.—General principles of distribution of weight, 105.—Difference of weights on rails and on springs at each axle, 106.—Adjustment of weights by screwing up springs, 108.—Compensating levers, 110.—Same effect produced by adjustment of springs, 112.

*Discussion.*—Colburn, Z., 115, 118.—Neilson, W. M., 117.—Ramsbottom, J., 114, 118.—Reynolds, E., 118.—Robinson, J., 114, 117.—Siemens, C. W., 114.—Webb, F. W., 115.

LOCOMOTIVES, EXHIBITION, *Paper* on the locomotive engines in the International Exhibition of 1862, by D. K. Clark, 1863, 78.—Inside-cylinder engines, 79.—Outside-cylinder engine, 80.—Trough and scoop for supplying water while running, 81.—Inside-cylinder express engines, 81.—Large driving wheels, 83.—Long sloping firebox with midfeather, 85.—Flanged joints for boiler, 87.—Steel tyres, 89.—Tank locomotives, 90.—Foreign locomotives, 91.—Solid wrought-iron wheels, 92.—“Dromadaire” tank



## LOCOMOTIVES, EXHIBITION (continued).

engine for heavy gradients, 92.—Four-cylinder tank engine, 93.—Meyer's "articulated" engine, 95.—Austrian "duplex" engine, 97.—"Steierdorf" engine with five coupled axles, 98.—Use of steel in Prussian engines, 99.—General conclusions, 101.—Tabular descriptions, 106.

*Discussion.*—Bouch, W., 110.—Clark, D. K., 108, 109, 110.—Ferne, J., 110.—Lloyd, Sampson, 108, 109, 110, 111.—Webb, F. W., 108.

LOCOMOTIVE, EXPRESS, *Paper* on an express engine, by W. Weallens, 1849, Apl., 8.—Engine for express trains between Newcastle and York, 8.—Valves on outer side of cylinders with eccentrics outside wheels, 8.—Bearings inside for crank axle, outside for leading and trailing axles, 8.

*Discussion.*—Beyer, C. F., 9.—McConnell, J. E., 9.—Stephenson, R., 9.

LOCOMOTIVE FEED-PIPE CONNEXION. *See* Feed-Pipe Connexion, 1862, 88.

LOCOMOTIVE LINK-MOTION. *See* Link-Motion, 1856, 70.

LOCOMOTIVE SHED. *See* Engine Shed, 1851, Jan., 22.—1858, 256.

LOCOMOTIVE WATER SUPPLY, Water Raising Apparatus, *Paper* on Fryer's apparatus for filling locomotive tenders with water, by J. Fenton, 1859, 211.—Description of apparatus, 211.—Experiments showing only slight fall of pressure in boiler when filling tender, 213.—No trouble from frost, 213.

*Discussion.*—Bastow, S., 216.—Fenton, J., 214, 216.—Fryer, A., 214.—Penn, J., 215.—Williams, R. P., 216.

LOCOMOTIVE WATER SUPPLY, *Paper* on a method of supplying water to locomotive tenders whilst running, by J. Ramsbottom, 1861, 43.—General description, 43.—Scoop, 44.—Water trough, 44.—Regulating supply-cistern, 45.—Ice plough, 46.—Principle of action, 46.—Experiments, 47.—Velocimeter, 49.—Advantage gained by this plan, 49.

*Discussion.*—Clift, J. E., 52.—Fothergill, B., 52.—Markham, C., 51.—Marshall, W. P., 52.—Ramsbottom, J., 50, 52.

LONDON Summer Meetings, 1851, June, 3.—1862, 93.

LONGRIDGE, R. B., elected Member, 1856, 7.

Boiler Economy, *Paper* on the relative economy and durability of various classes of stationary steam boilers, 1859, 147.—Galloway multitubular boiler, high evaporative duty, 163.

Boiler Explosions, proportion of explosions due to negligence of attendants, &c., 1870, 202.—Cornish boilers safer than plain cylindrical, 202.—Overheating of plates from incrustation, 202.—Grease from exhaust steam causes injury to boiler when water contains carbonate of lime, 203.—Sulphate of lime not so injurious as carbonate, 203.

Steam Engine, hot-air casing instead of steam-jacket, very successful, 1855, 205.

LONGRIDGE, W. S., elected Member, 1865, 218.

Boilers, Corrosion of, manufacture of boilers in complete rings, 1866, 76.

LONGSDON, A., elected Honorary Member, 1865, 102.

LORD, E., elected Member, 1866, 264.

LORD, J., elected Honorary Member, 1848, Apl., 24.

LORD, T. W., elected Member, 1859, 97.—Decease, 1871, 2.—Memoir, 16.

LOW, G., elected Member, 1861, 53.

Rock-Boring Machine, *Paper* on a rock-boring machine, 1865, 179.—

Frequency of sharpening tools, 191.—Weight of machine, 194.

LOWE, J. E., elected Member, 1873, 88.

LOXTON, J., elected Member, 1862, 20.

LUBRICATION, *Paper* on railway axle lubrication, by W. B. Adams, 1853, 57.—

Action of lubrication, 57.—Pressure on axles, 58.—Ordinary mode of lubrication, 58.—Description of improved axlebox, 60.—Movable journals for axles, 61.—Long axle bearings, 61.—Double-cone journal, 62.

*Discussion*.—Adams, W. B., 63, 64, 65.—Allan, A., 64.—Cowper, E. A., 64.—Lea, J., 65.—Slate, A., 63, 64, 65.

LUBRICATION, *Paper* on a new lubricating material, by J. Lea, 1853, 65.—

Objections to ordinary lubricants, 65.—New lubricating compound, 66.—Saving in cost of engine lubrication, 67.

*Discussion*.—Everitt, G. A., 68.—Lea, J., 68.—Slate, A., 68.

LUCAS, A., elected Member, 1873, 250.

LUCY, W., elected Honorary Member, 1850, Jan., 5.

LUDERS, T. L., Boiler, Cast-Iron, Harrison's, application to puddling furnaces,

1864, 81.—Cost of boiler, 82.—Temperature of waste heat, 82.—Facing-machine for joints, 84.—Freedom from scale and rust, 84.—Oblique setting, 85.—Feed and steam pipes, 86.—Joints, 87.—Blowing out scale, 88.—Long period of working without need of opening boiler, 91.

LUKIN, A. S., elected Member, 1872, 75.

LUNDH, S. H., elected Member, 1865, 20.

LYNDE, J. G., elected Member, 1854, 110.

LYNDON, G. F., elected Member, 1868, 212.

LYSTER, G. F., elected Member, 1872, 119.

## M.

MABBUTT, T., elected Member, 1869, 77.

MACFARLANE, W., elected Member, 1864, 271.

MACGREGOR, J., elected Honorary Member, 1848, July, 20.—Decease, 1859, 2.

MACGREGOR, W. F., elected Member, 1848, July, 20.

MACKAY, J., elected Member, 1856, 250.

- MACKENZIE, W., Ventilation, Mechanical, *Paper* on the mechanical ventilation and warming of St. George's Hall, Liverpool, 1863, 194.—Objectionable to admit fresh air above and draw off foul air below, 204.
- MACLAREN, R., Water Works, success of bored and turned joints at Dublin, 1863, 188.—Cost of pipes with bored and turned joints, 188.
- MACNAB, A. F., elected Member, 1864, 271.
- MACNAY, W., elected Member, 1865, 102.
- MACNEE, D., elected Member, 1865, 102.
- MADIGAN, R., elected Member, 1847.
- MAGNETIC WATER GAUGE. *See* Water Gauge, 1860, 83.
- MAIR, J. G., elected Member, 1873, 45.
- MALLET, R., elected Member, 1867, 234.
- Corn-Mill, Buchholz, cerealine contains nitrogenous portion of flour, therefore undesirable to remove it, 1872, 238.
- Docks, Floating, difficulty in erecting floating docks, 1867, 106.—Slip for launching ships broadside, 106.
- Flow of Solids, fibre of iron only elongated crystals, 1867, 145.—Separation of zinc from brass under pressure, 146.
- Hydraulic Machinery, letter from J. Bramah suggesting application of principle of hydraulic press to cranes, &c., 1868, 40.
- Printing Machine for Bank Notes, former plan of printing bank notes, 1865, 176.—Present machine very perfect, 177.
- Well-Boring, difficulty of boring through hard mass with inclined surface, 1867, 189.—Wooden rods with steel couplings, 190.
- MALTBY, W., Sand-Blast Process, gives sharper edge to pattern than etching by fluoric acid, 1873, 277.
- MANBY, C., elected Honorary Member, 1860, 53.
- MANCHESTER Summer Meetings, 1857, 85.—1866, 103.
- MANCHESTER WATER WORKS. *See* Water Works, 1866, 245.
- MANNING, J., elected Member, 1859, 53.
- Brick-Making, cost of labour, &c., in making bricks by machine, 1859, 259.
- Steam Road Roller, thorough efficiency of Paris rollers, 1869, 114.
- MANSELL, R. C., elected Member, 1862, 47.
- MAPPIN, F., elected Graduate, 1868, 212.
- MAPPIN, F. T., elected Member, 1862, 47.
- MARCH, G., elected Member, 1857, 201.
- MARINE ENGINES, *Paper* on the commercial economy of working steam expansively in marine engines, with description of a new double expansive marine engine, by E. E. Allen, 1855, 59.—Power developed by expanding steam, 59.—Proportion in weight of coals to machinery in steamers, 61.—Early notice of economy of expanding steam, 62.—Weight of machinery and coals with increased size of engine, 64.—Space occupied by coals and

## MARINE ENGINES (continued).

by engines, 65.—Weights of different parts of machinery, 66.—Space occupied by machinery and coals, 67.—Tables of do., 68, 69.—Cost of engines, &c., 70.—Cost of vessels and their coals, 71.—Table of do., 72.—Working expenses, 73, 74.—Increased dividend on capital from economy of expansive working, 75.—Tables of do., 77, 78, 79.—Effect of increasing size of engines, 80.—Table of do., 81.—Effect on cargo space, &c., of increased size of engines, 82, 83, 84.—General summary, 87.—Objects to be attained in expansive engine, 90.—Description of proposed expansive engine, 91.—Double-acting arrangement of engine, 92.

*Discussion.*—Allen, E. E., 93, 94, 95.—Fairbairn, W., 93, 94, 95, 96.—Jackson, P. R., 95.—Miller, J., 95.—Wills, W. R., 93.

MARINE ENGINES, *Supplementary Paper* on the commercial economy of working steam expansively in marine engines, by E. E. Allen, 1855, 97.—Three ways of increasing economy from expansion, 98.—Table of power developed and volume of steam at different pressures, 100.—Relative economy of increased pressure and increased size of engines, 102.—Economy from increased pressure in same cylinder, 103, 104.—Table of weights of machinery and coal with increased size of engines, 105.—Table of spaces occupied by do., 106.—Gain in cargo space by do., 107.—Tabular summary of results of increased size of engines, 108.—Tables of results of increased steam pressure, 110, 111, 112, 113.—Advantages of proposed new form of engine, 115.

*Discussion.*—Allen, E. E., 118, 119, 120, 121, 122, 123, 124.—Garland, W., 124.—Hodge, P. R., 119, 120, 121.—Jones, E., 119.—McConnell, J. E., 118, 119, 120, 121, 122, 123, 124.—Shipton, J. A., 122, 123.

MARINE ENGINES, *Paper* on a direct-action marine engine for screw propulsion, by E. Hunt, 1856, 159.—Importance of compact engines for screw propellers, 159.—Description of engine, 160.—Z crank, 161.—Action of engine, 161.—Compact arrangement of engine, 162.—Modifications, 163.

*Discussion.*—Dunn, T., 164.—Harvey, R., 164.—Hunt, E., 164.—Morrison, R., 164.—Whitworth, J., 164.

MARINE ENGINES, *Paper* on the progress effected in economy of fuel in steam navigation, considered in relation to compound-cylinder engines and high-pressure steam, by F. J. Bramwell, 1872, 125.—Former disregard to economy of fuel, 125.—Old forms of marine boilers and engines, 128.—Early attempts at using steam of higher pressure, 130.—Early condensers, 131.—English steamers in 1839, 133.—Improvement in engines and increase of boiler-pressure, 133.—Revival of surface condensers, 134.—Compound-cylinder engines, 135.—MacNaught's arrangement, 136.—Simpson's pumping engines with special valve, 136.—Compound-cylinder marine engines, 137.—Single-cylinder engines in American river boats,

## MARINE ENGINES (continued).

141.—Variation in tangential force, 142.—Shock on working parts with single cylinders, 143.—Description of indicator diagrams, 145.—Various arrangements of compound engines, with particulars of working, 146 to 153.—Marine boilers, 154.—Superheating of steam, 155.—Surface condenser, 156.—Tables of consumption in compound marine engines, 159.—Boilers, do., 160.—Surface condensers, do., 161.—Steamships with compound engines, 162.

*Discussion.*—Allfrey, E. R., 175, 178.—Bramwell, F. J., 163, 165, 181.—Crampton, T. R., 166, 173, 178.—Gray, J. McF., 168.—Gurden, C. F., 175, 179.—Head, J., 171.—Humphrys, R. H., 166.—Jamieson, J. L. K., 163, 172.—Laird, W., 177, 179.—Ramsbottom, J., 179.—Siemens, C. W., 163, 165, 171, 184.—Thompson, W., 164, 165, 174.

MARINE ENGINES, CONDENSATION. *See* Condenser, 1862, 99.

MARINE ENGINE GOVERNOR. *See* Governor, 1853, 117.—1859, 92.

MARKHAM, C., elected Member, 1856, 49.

Blast-Furnace Waste Gas, successful application of waste gas to heating boilers in France, 1860, 128.

Coal Burning in Locomotives, *Paper* on the burning of coal instead of coke in locomotive engines, 1860, 147.—Durability of deflecting plates, 173.

Decimal Measurement, advantages of inch over metre as standard unit, 1860, 230.

Locomotive Water Supply, thorough efficiency of Ramsbottom's apparatus, 1861, 51.

Safety Wagon Coupling, *Paper* on a new safety coupling for railway wagons, 1860, 277.—Former mechanical coupling not successful, 282.

Steam Hammer, *Paper* on Naylor's double-acting steam hammer, 1857, 233.

Superheated Steam, gain from superheating, greatly due to increased heating surface of boiler, 1860, 29.

Surface Condensers, effect of pure water in removing incrustation, 1863, 157.

MARSDEN, H. R., Stone-Breaking Machine, Blake's, breaking granite and emery, 1864, 25.—Cost of machine, 26.—Crushing of hammer-heads accidentally dropped into machine, 27.—Inclination of jaws, 27.—Very little dust produced, 30.—Different forms of teeth of jaws, 32.

MARSH, H. W., elected Member, 1871, 117.

MARSH, S., elected Associate, 1871, 262.

MARSHALL, E., elected Member, 1848, Apl., 23.—Decease, 1865, 2.—Memoir, 15.

MARSHALL, F. C., elected Member, 1865, 53.

MARSHALL, JAMES (Gainsborough), elected Member, 1871, 262.

MARSHALL, JAMES (Seaton Delaval), elected Member, 1862, 20.

MARSHALL, JOHN, elected Honorary Member, 1856, 250.

MARSHALL, P. P., Water Works, "preventors" for stopping waste, 1863, 190.—Great waste of water in North London district, 191.



MARSHALL, W. E., elected Member, 1859, 14.

MARSHALL, W. P., elected Member, 1847.—Secretary, 1849, Jan., 8.

Crushing Machine, *Paper* on Berdan's crushing and amalgamating machine, 1854, 33.

Rifles, Breech-Loading, *Paper* on the principal constructions of breech-loading mechanism for small arms, and their relative mechanical advantages, 1871, 92.

MARTEN, E. B., elected Member, 1859, 53.

Aero-Steam Engine, air-injection entirely prevents scale, 1870, 239.—Very valuable in assisting evaporation, 240.—All sediment blown out when blowing-off, 244.

Boilers, Perkins and Benson boilers successful at high pressure, not at low, 1871, 245.

Boiler Explosions, *Paper* on steam boiler explosions and their records, and on inspection as a means of prevention, 1866, 130.—Sand not very successful covering, 179.

Boiler Explosions, *Paper* on the conclusions derived from the experience of recent steam boiler explosions, 1870, 179.—Not much advantage in having plates thicker than necessary, 199.

Boiler Lining, collecting pans very useful so long as regularly emptied when full, 1871, 58.—Whittle lining very successful in removing scale, and increasing evaporative duty of boiler, 58.

Indicator, Continuous, particulars of comparison with ordinary indicator, 1871, 89.

Pressure Gauges, seldom correct, frequently too low, 1871, 289.—Special gauge for testing boilers, 289.

Riveted Joints, greater thickness of iron in joint exposed to fire, more readily burnt, 1872, 89.—Lap-joints stand better than butt-joints, 89.—Double-riveted joints seldom give way, 89.—Diagonal-jointed boiler, good construction, 89.—Strength of iron against different strains varies much, 90.

MARTEN, G. P., elected Member, 1860, 89.

MARTEN, H. J., elected Member, 1853, 8.

Blast Furnaces, increase in size of furnaces in Shropshire attended with lower consumption, 1869, 40.

Hot-Blast Ovens, *Paper* on the construction of hot-blast ovens for iron furnaces, 1859, 62.—Prejudice against hot blast because iron can be made from inferior materials, 89.—Efficiency of round ovens, 90.—Admiralty report adverse to hot-blast iron, based on very insufficient data, 101.—Classification of various ironstones, 103.—Hot-blast iron of good quality quite equal to cold-blast, 104.—Very small reduction of pressure in blast passing through improved oval ovens, from absence of leakage, 108.

MARTEN, H. J. (continued).

Pumping Engine, durability of Hosking's india-rubber ball valves, 1859, 59.

Water-Works Engines, *Paper* on the pumping engines of the Wolverhampton Water Works, with some remarks on water pumping, 1856, 7.—Engine with heavy beam, higher duty than with light beam, 21.—Sand covering for boilers very successful, 22.

MARTIN, W., elected Member, 1867, 234.

MARTINDALE, B. H., Lt.-Col., elected Member, 1857, 202.

MARTINEAU, F. E., elected Member, 1854, 110.

MARTLEY, W., elected Member, 1864, 121.

MASSELIN, A., elected Member, 1857, 55.

Lighthouse Apparatus, *Paper* on the construction of lighting apparatus for lighthouses, 1862, 48.—Adjustment of lamp, 61.—Liability to accident in old form of pressure lamp, 62.—Range of light, 63.—Reflecting lights still in use, 63.—Extension of lighthouse system, 64.—Adjustment of glass prisms, 65.—Setting of prisms, 66.—Grinding and polishing of prisms, 66.

Wrought-Iron Lighthouse, construction of Buda lighthouse appears hardly strong enough, 1861, 27.

MATHER, W., elected Member, 1867, 59.

Well Boring, boring with rope instead of with rods in England, 1867, 185.

Well Boring, *Paper* on well boring and pumping machinery, 1869, 278.—Action of claw-grapple, 304.—Extracting rope from bore-hole, 308.—Durability of ropes, 308.—Rope system not recommended for shallow bore-holes, 309.

MATHEWS, W., elected Member, 1853, 45.—Council, 1854, 5.—Decease, 1872, 2.—Memoir, 19.

Blast Furnaces, no great advantage from use of waste gases in Scotland, 1852, 204.

Blast-Furnace Waste Gas, not much margin for economy where slack is very cheap, 1860, 270.

Coal, South Staffordshire Thick, *Paper* on the ten-yard coal of South Staffordshire and the mode of working, 1860, 91.

Safety Mine Apparatus, very few accidents from breakage of winding rope, 1854, 61.

MATTHEW, J., elected Member, 1848, Apl., 23.

MATTHEWS, T. B., elected Associate, 1868, 104.

MATTHEWS, W. A., elected Member, 1847.—Council, 1849, Jan., 9.—1851, Jan., 8.—Decease, 1873, 2.—Memoir, 18.

MAUDSLAY, H., elected Member, 1853, 75.—Council, 1855, 5.—Vice-President, 1857, 11.—1858, 12.—1859, 13.—1860, 13.—1861, 13.—1862, 19.—1863, 14.—1864, 18.—1865, 19.—1866, 16.—1867, 17.

## MAUDSLAY, H. (continued).

Library, donation of books, 1857, 202.

Pump, Horizontal V, advantageous for pumping very dirty water, 1864, 40.

Pumping Engines, dished valves to allow free action of india-rubber disc, 1858, 59.—Direct-acting vertical pumping engines for irrigation from Nile, 61.—Important to allow india-rubber valves to shift on their seats, 1859, 59.

Regenerative Furnace, simple form of regenerator for balling furnace, 1857, 110.

Rolling Mill, angle-iron turned over when passed back over top roll, to knock scale off, 1866, 127.

Safety Valves, piston valves liable to stick from deposit on rubbing surface, 1859, 193.

Steam Hammer, arrangement for changing anvil face, 1855, 16.

Stephenson, Robert, notice of decease, 1859, 245.

Tools, punched holes quite satisfactory for riveting two plates together, 1864, 211.—Reason for preferring drilled holes for bridge work, 211.

Wood Bearings, great success of screw-shaft bearings, 1858, 88.

MAUDSLAY, T. H., Jun., elected Member, 1864, 59.

MAUGHAN, T., elected Member, 1869, 120.

MAW, W. H., elected Member, 1873, 25.

MAY, C., elected Member, 1859, 14.—Decease, 1861, 2.

Axles, experiments on reduction of strength per square inch when outside of iron bar removed, 1853, 99.—Skin of iron probably not stronger than interior, 99.

Brick Machinery, difficulty in getting dry-clay bricks burnt sufficiently, 1859, 47.—Heavy expense for wear and tear in most brick-making machinery, 48.—Usual cost of hand-made bricks in London, 50.—Variation in size of bricks, 261.

Governor, chronometric governor thoroughly successful, 1853, 86.—Example of rapidity of action, 87.

Railway Chairs, no allowance for expansion in laying Barlow rails, 1853, 106.

MAY, G., elected Member, 1869, 120.

MAY, R. C., elected Member, 1861, 14.—Nominated Commissioner of Patents, 1868, 49.

MAY, W., elected Member, 1857, 55.—Council, 1861, 13.—1864, 18.—1866, 16.—1869, 19.—1872, 25.

High-Pressure Steam Engine, works well, boiler very safe and easily repaired, 1861, 105.

Steam Hammer, elastic anvil to diminish breakages, 1855, 14.

MAYER, J., elected Member, 1860, 250.

MAYHEW, H., elected Graduate, 1867, 19.

MAYLOR, J., elected Member, 1865, 218.

MAYLOR, W., elected Member, 1859, 14.

MAYNARD, J., Capt., Ore-Dressing Machinery, mode of removing wolfram from tin ore, 1873, 142, 143.

MCCLEAN, J. R., elected Member, 1847.—Council, 1852, 8.

MCCONNELL, J. E., Original Member, 1847.—Vice-President, 1847.—1848.—1849, Jan., 9.—1850, 4.—1851, 8.—1852, 8.—1853, 7.—Council, 1854, 5.—Vice-President, 1855, 5.—1856, 6.—1857, 11.—Council, 1858, 12.

Axles, *Paper* on railway axles, 1849, Oct., 13.—Broken axles crystalline around fracture, though fibrous in centre, 24.—Only very small tapered shoulder allowed on axle at wheel, 24.—Axle crystalline in fracture restored to fibrous state by heating and hammering, 26.

Axles, *Supplementary Papers* on the deterioration of railway axles, 1850, Jan., 5.—Apl., 3.—Doubtful if tough iron is really fibrous, 9.—Action of vibratory wave on axle, 9.—Square shoulder at wheel boss very objectionable, 1850, Oct., 11.—Precautions necessary in experiments on axles, 15.

Axles, *Paper* on hollow railway axles, 1853, 87.—Gauge for testing thickness of metal in hollow axles, 96.—Breakage of fibrous iron from crystallisation by repeated concussion, 97.—Hollow axles not so much affected by repeated blows as solid axles, 100.

Axlebox, oil best for lubrication, 1852, 217.—Cotton-waste better than sponge for oiling axle, 221.

Balancing of Wheels, *Paper* on the balancing of wheels, 1848, June, 2.—Each wheel requires balancing separately, not correct to balance the whole attached together, 7.—Want of balance in pistons and rods causes accidents, even with wheels in balance, 7.

Boring Locomotive Cylinders, cylinder supplied perfectly fitted to replace a broken one, 1848, Apl., 3.

Decimal Measure, inaccuracy of present fractional system, 1857, 143.—Inch best unit for England, 143.

Expansion of Steam, reports of engine performance required from other districts besides Cornwall, 1849, July, 30.

Express Engine, port faces easy to get at for repairs, being outside, 1849, Apl., 9.

High-Pressure Boilers, explosion of boiler from want of circulation of water in lower tubes, 1848, July, 15.

Lifting Machine, *Paper* on a new portable lifting machine, 1852, 88.

Locomotive Boiler, heat lost by air in centre of tubes not coming in contact with sides, 1849, July, 9.—Mixing up currents of air in flues of marine

McCONNELL, J. E. (continued).

and stationary boilers, 9.—Diminishing resistance in tubes by increasing their number, 10.—Small tubes and large number produce best effect, 11. Permanent Way, limited breadth of bearing surface for wheels on rail, 1849, Apl., 31.

Piston, *Paper* on an improved wrought-iron piston, 1854, 119.

Railway Economy, necessary to provide for maximum of power wanted, 1849, Oct., 9.—Smaller power of engines applicable on branch lines, 9.—Small engines on Birmingham and Gloucester line, not able to take the traffic, 11.—Ordinary carriages very great weight per passenger, 11.

Safety Buffer, difficulty with centre rigid bar, because ordinary buffers not all ranged in a line, 1848, Apl., 17.—Tendency to throw off middle of train on a curve, 17.—If centre buffer-rod swerved, great destruction would be caused in carriage when rod broke, 18.

Starting Apparatus, great advantage of hydraulic apparatus in avoiding end pressure, 1848, Apl., 14.—Objection to conical clutch, 15.

Steel Manufacture, steel tyres in Prussia, 1857, 168.

McCONNOCHIE, J., elected Member, 1872, 26.

McCONNOCHIE, J., elected Member, 1849, Apl., 32.

Railway Chair, *Paper* on an improved railway chair, 1853, 9.—Weight of new chairs, 17.

McCORMICK, S., elected Member, 1849, July, 39.

McDONNELL, A., elected Member, 1865, 102.

McEWEN, J., elected Member, 1867, 60.

McEWEN, L. T., elected Member, 1864, 271.

McKAY, B., elected Member, 1868, 103.

McKENZIE, JAMES, elected Member, 1860, 89.

McKENZIE, JOHN, elected Member, 1859, 247.

McNEILE, A., elected Member, 1872, 119.

McPHERSON, H., elected Member, 1862, 93.

MEASUREMENT, DECIMAL. *See* Decimal Measure.

MEASUREMENT, PROOF of Guns by. *See* Guns, Proof of, 1866, 105.

MECHANICAL FIRING of Steam Boilers. *See* Steam Boilers, 1869, 155.

MECHANICAL PUDDLING. *See* Puddling, Mechanical, 1864, 298.—1867, 151.

MECHANICAL VENTILATION and Warming. *See* Ventilation, Mechanical, 1863, 194.

MEEK, S., elected Member, 1863, 246.

MEIK, T., elected Member, 1858, 266.

MEMOIRS of Deceased Members, 1862, 14.—1863, 13.—1864, 13.—1865, 13.—1866, 14.—1867, 14.—1868, 14.—1869, 15.—1870, 14.—1871, 15.—1872, 15.—1873, 16.



MENELAUS, W., elected Member, 1857, 55.—Council, 1868, 19.—Vice-President, 1870, 18.—1871, 20.—1872, 25.—1873, 24.

Coal-Cutting Machinery, holing forms only small portion of work in South Wales, 1868, 148.—Compressed-air machine has not much effect on ventilation, 150.—Machine not of much use in soft South Wales coal, 1872, 221.—In thin hard seams machines very useful, 222.—Winstanley and Barker's machine appears one of the best, 222.—Discharge of exhaust air has not much effect on ventilation, 223.

Dowlais Ironworks Engines, *Paper* on the large blowing engine and new rolling mill at Dowlais Iron Works, 1857, 112.—Connecting-rod of oak, 116.—Weight of engines, 116.—Set of four rolls for rolling very long bars, 117.—High speed of rolls, 118.

Puddling, Mechanical, *Paper* on mechanical puddling, 1867, 151.—Mechanical puddling not successful yet, 161.—Speed of revolution of puddling vessel, 161.—Loss of iron, 162.—Failure of linings, 162.—Iron rendered useless when lining much destroyed, 165.—Great uniformity in results of mechanical puddling, 168.—Lining of coke and tar not successful, 168.

MEREDITH, A., elected Member, 1866, 103.

MERRYWEATHER, R. M., elected Member, 1867, 234.

METAL ORNAMENTATION, by rolling sheets of metal with lace, &c., between, by R. W. Winfield and R. F. Sturges, 1853, 73.—By Tilghman's sand-blast process, 1873, 269, 275.

METAL STAMPING, new process of, by Messrs. Salt and Lloyd, 1853, 73.  
*See also* Hammer, Compressed-Air, 1865, 94.

METALLIC RODS, *Paper* on a new manufacture of compound metallic rods and bars, by E. J. Payne, 1855, 18.—Mode of building up billets for making rods, 18.—Increased strength of rods, 19.—Cost, 20.—Piles for rails, 20.—Copper tubes, 21.

*Discussion.*—Clift, J. E., 23.—Everitt, G. A., 24.—Fairbairn, W., 21, 22, 24.—Fenton, J., 23.—Fothergill, B., 22, 23.—Mathews, W., 22, 24.—Maudslay, H., 23.—May, W., 22.—Payne, E. J., 22, 23, 24.

METER, GAS. *See* Gas Meter, 1860, 15.

METER, WATER. *See* Water Meter, 1851, Jan., 19.—1856, 113, 151, 242.—1857, 72.

METFORD, W. E., elected Member, 1857, 55.

METRIC SYSTEM of Weights and Measures. *See* Decimal Measure, 1865, 21.

MICHELL, F. W., Engines, Portable, for Mining, evaporative duty of Cornish boilers, 1873, 181.—Inferior quality of coal in Cornwall, 182.—Non-condensing engine not best for winding, 182.—Friction of Cornish engines, 182.

MIDDLESBROUGH Summer Meeting, 1871, 117.

MIDDLETON, H. C., elected Graduate, 1861, 211.

MIDDLETON, W., Original Member, 1847.—Decease, 1869, 2.—Memoir, 16.

MIDLAND COLLIERY WORKING. *See* Colliery Working, Midland, 1870, 146.

MIERS, F. C., elected Member, 1862, 93.

MIERS, J. W., elected Member, 1864, 271.

MILLER, G. M., elected Member, 1853, 45.—Decease, 1865, 2.—Memoir, 16.

Packing for Pistons, *Paper* on a packing for pistons of steam engines and pumps, 1862, 315.—Mode of making steel packing rings, 320.—Durability of cylinders much increased, 321.—No pressure on cylinder when running without steam, 325.—Badly worn cylinder restored to shape by adoption of steam-packed rings, 326.—Rolled brass too soft for rings, 327.

Valve Motion, *Paper* on a new expansive valve-motion for steam engines, 1855, 146.—Movement not same as in link motion, 152.—Small cost of maintenance, 153.

MILLER, J., Original Member, 1847.—Vice-President, 1847.—1848.—1849, Jan., 9.—Decease, 1861, 2.

Rotary Engine, advantage in rotary engine from small space occupied, but great difficulty in keeping steam-tight, 1848, July, 5.

MILLER BOILER. *See* Boiler, Cast-Iron, 1871, 263.

MILLER PRESSURE GAUGE. *See* Pressure Gauges, 1871, 281.

MILLS, G., elected Member, 1847.

MILLWARD, J., elected Member, 1862, 93.

MILNER, J., Original Member, 1847.

MINERALS, CORNWALL and West Devon, description of, 1873, 107.

MINE VENTILATION. *See* Ventilating, and Ventilation.

MINING, CLEVELAND, *Paper* on the general geological features of the Cleveland iron district, by J. Jones, 1871, 184.—Position and geological features of district, 185.—Salt beds in Keuper marls, 185.—Main ironstone seam in middle lias, 187.—Analysis of ironstone, 188.—Jet and alum shales, 189.—Great whin dyke, 190.—Mode of working ironstone seams, 192.—Ventilation of workings, 193.—Durham coalfield, 194.—Statistics of iron trade of district, 195.

*Discussion.*—Jones, J., 196, 198.—Marley, J., 196.—Ramsbottom, J., 199.—Siemens, C. W., 197.—Steavenson, A. L., 196.—Whitley, J., 198.—Wilson, J. F., 196.

MINING, CORNWALL, *Paper* on the mining district of Cornwall and West Devon, by J. H. Collins, 1873, 89.—Geological structure, 89.—Mineral lodes, 91.—Tin and copper lodes mostly near junction of granite and killas, 91.—Veins, &c., are true fissures, 92.—Mean directions of lodes, 92.—Veins of different ages, 93.—Elvans, 94.—Tin and copper mines, 95.—Shafts, 95.—Adits, 96.—Pumping, 97.—Falling-off in duty of Cornish

## MINING, CORNWALL (continued).

pumping engines, 97.—Levels and winzes, 98.—Lodes vary in richness, 98.—Pay of miners, 99.—Blasting, 100.—Dynamite valued for wet holes, 100.—Conveyance of stuff, winding, &c., 100.—Ventilation, 101.—Man-engine, 101.—Quantities and values of ores, 102.—Lead and iron ores, 103.—China-clay, 104.—Other minerals, 106.

*Discussion.*—Bennetts, Capt. J., 113.—Bramwell, F. J., 118.—Cochrane, C., 117.—Collins, J. H., 107, 113, 114, 115, 118.—James, S. H., 113.—Head, J., 117.—Husband, W., 114, 115.—Taylor, R., 109, 116, 117.

MINING, CORNWALL. *See also* Ore-Dressing Machinery, 1873, 119.—Restronguet Tin Stream Works, 1873, 155.

MINING ENGINES, Portable, *Paper* on the application of portable engines for mining purposes, by J. Richardson, 1873, 167.—Comparison of portable engines with old beam engines, 167.—Self-propelling portable engine for sinking trial pits, 169.—Semi-portable engine for permanent winding and pumping, 170.—Semi-portable engine with two drums for tail-rope hauling at bottom of shaft, 171.—Pair of semi-portable engines coupled for heavy work, 171.—Saving in fuel, attendance, first cost, &c., of portable engines, 172.—Semi-portable engines now in use, 173.—Durability of steel-wire ropes on small drums, 174.

*Discussion.*—Amos, C. E., 184.—Bramwell, F. J., 175, 188, 189, 193, 199.—Easton, E., 186.—Froude, W., 176, 199.—Halpin, D., 183.—Head, J., 176, 180, 188, 189.—Hughes, G. D., 182.—Husband, W., 176, 177, 178, 188, 189, 198.—Lawrence, H., 187.—Lean, T., 177, 183, 189, 190, 198.—Michell, F. W., 181.—Richardson, J., 175, 176, 177, 178, 191.—Taylor, R., 184, 187, 189.

MINING MACHINERY, *Paper* on the progressive application of machinery to mining purposes, by T. J. Taylor, 1859, 15.—Old workings near surface, 15.—Early period of coal mining, 16.—Water raised often greatly in excess of coal raised, 17.—Middle period of coal mining, 17.—Chain pumps, 18.—Horse gin, 20.—Early German mining much ahead of English, 20.—Pumps worked by crank and flywheel, 21.—“Stook and feathers” for wedging down hard rock, 21.—Rag pump, 22.—Introduction of railways, 22.—Third period of coal mining, 23.—Early applications of steam engine, 24.—Pumping at Hartley Colliery, amount of water, and cost, 25.—Direct-acting pumping engines, 25.—Water-balance for raising coals, 26.—Double water-wheel, 27.—Double-cylinder winding engine, 28.—Cost of raising from different depths, 29.—Railways underground not used till sixty years ago, 30.—Underground haulage, 30.—Ventilation, underground furnace, 31.—Mechanical ventilators, 32.—Steel mill for lighting, 33.

## MINING MACHINERY (continued).

*Discussion.*—Bramwell, F. J., 36.—Cowper, E. A., 39.—Longridge, H. G., 35, 40.—Maudslay, H., 36.—May, C., 38.—McConnell, J. E., 34, 40.—Penn, J., 34, 40.—Siemens, C. W., 37, 38, 40.—Taylor, T. J., 34, 35, 37, 38, 39, 41.

MITCHEL, W. H., Type-Setting Machines, *Paper* on a type-composing and distributing machine, 1863, 34.—Number of machines at work, 56.—Cost, 56.

MITCHELL, C., elected Member, 1856, 79.

MITCHELL, JAMES, elected Member, 1858, 80.

MITCHELL, JOHN, elected Graduate, 1867, 60.

MITCHELL, JOSEPH, elected Member, 1861, 109.

MOBERLY, C. H., elected Member, 1870, 19.

MOLE, T., elected Member, 1848.

MÖLLER, P. T., elected Member, 1873, 88.

MOON, R., Jun., elected Member, 1872, 75.

MOOR, W., elected Member, 1859, 14.

Coal-Cutting Machinery, successful working of pick machine at Hetton Colliery, 1868, 157.

MOOR, W., Jun., elected Graduate, 1868, 212.

MOORE, R., Coalfield, Glasgow, difference between action of coal-cutting machine and hand pick, 1864, 245.—Mode of building air-tight pack walls, 247.

MOORE, S., elected Member, 1864, 59.

MOORE, W., Coalfield, Glasgow, *Paper* on the principal seams of coal and ironstone in the Glasgow coalfield, 1864, 229.—Comparative durability of hemp and iron wire ropes, 247.

MOORSOM, W. M., elected Member, 1872, 75.

Counter-pressure Steam Break, trials on London and North Western Railway, 1870, 50.—Injectors failed to work unless excess of water jet in exhaust pipe, 51.

Ventilating Fan, influence of direction of gauge orifice in measuring air-currents, 1871, 31.—Similar experiment on fan-blast, 33.

MORGAN, J. L., elected Member, 1864, 271.

MORGANS, T., elected Member, 1867, 18.

MORIN, A., Gen., elected Honorary Life Member, 1868, 5.

Ventilation of Buildings, *Paper* on the ventilation of public buildings, 1867, 61.—No necessity for moistening the heated air, 75.—Objectionable to introduce air at floor, 76.—Means of cooling air in warm climates, 77.

MORISON, D. P., Ventilation of Mines, loss of effect from spiral casing to fan, 1869, 152.

MORRIS, W., elected Member, 1868, 212.

MORRISON, H. M., elected Member, 1873, 45.

MORRISON, R., elected Member, 1849, Oct., 32.

Pile Driver, *Paper* on an improved steam pile-driver, 1856, 287.

Pumping Engine, *Paper* on the pumping engine at the Newcastle Water Works, 1859, 55.

Steam Crane, *Paper* on a direct-acting steam crane, 1859, 168.—Small condensation of steam, 175.—Hydraulic cranes wasteful when raising light loads, 176.—Size of turning-round piston, 178.

Steam Hammer, *Paper* on an improved steam hammer, 1855, 8.—Very successful working of hammer, 13.—Attachment of hammer head, 14.

MORTON, A., Ejector Condenser, *Paper* on the ejector condenser for steam engines, dispensing with an air-pump, 1872, 256.—Preferable to have condensing water supplied with head, 263.—Fluctuation in vacuum when exhaust discharged much above atmospheric pressure, 264.—Ejector condenser not applicable to marine engines, 264.—Fall of vacuum on diminution of supply of condensing water, 269.—Experiments on mode of action of condenser, 270.

MORTON, R., elected Member, 1865, 53.

MOSS, H. E., elected Honorary Member, 1856, 80.

MOSSE, J. R., elected Member, 1865, 20.

MOULDING and Casting, *Paper* on an improved system of moulding and casting, by R. Jobson, 1858, 14.—Moulding machine, 14.—Rapiditv of moulding railway chairs, 16.—Casting apparatus, 16.—Comparison of weights lifted in hand moulding and with machine, 17.—Advantages in labour, rapidity, space occupied, &c., 18.

*Discussion.*—Bennett, P. D., 21.—Clift, J. E., 20.—Cochrane, A. B., 20, 21.—Fenton, J., 19.—Fothergill, B., 21.—Jobson, R., 19, 20, 21.

MOULDING MACHINE, *Paper* on a new moulding machine for cog and other wheels, by P. R. Jackson, 1855, 41.—Defects of ordinary mode of casting wheels, 42.—Description of moulding machine, 43.—Cutting of pattern, 44.—Process of moulding, 45.—Advantages, 47.—Rapiditv of work, 48.

*Discussion.*—Fairbairn, W., 49, 50, 51, 52, 53, 54, 56.—Ferne, J., 51, 52.—Hawkes, W., 52, 53, 54, 55, 56.—Hodgkin, J. E., 50.—Jackson, P. R., 49, 50, 51, 52, 53, 54, 55, 56.—Ramsbottom, J., 51, 55, 56.

MOULDING MACHINE, *Paper* on the moulding of toothed wheels, and an improved wheel-moulding machine, by G. L. Scott, 1868, 238.—Objections to wood patterns, 239.—Description of machine, 240.—Process of moulding, 241.—Advantages of machine moulding, 244.—Rate of moulding large wheels, 245.

*Discussion.*—Bramwell, F. J., 246, 250.—Cowper, E. A., 246, 250.—Grierson, H. H., 247, 249.—Lloyd, W., 249.—Scott, G. L., 246, 247, 248, 249, 250.—Smith, W. F., 247.—Woods, H., 247, 248.



**MOULDS, CASTING**, *Paper* on an improved construction of moulds for casting metals, by R. Jobson, 1854, 62.—Ordinary plan of moulding, 63.—Description of improved system of moulding, 63.—Pattern used as face of ramming block, 66.—Metal face for ramming block, 67.—Steady-pin guides, 68.

*Discussion*.—Brown, R., 69.—Hodgkin, J. E., 70.—Jobson, R., 68, 69, 70.—Slate, A., 69, 70.

**MOUNTAIN, C. G.**, elected Member, 1858, 45.

**Stone-Crushing Machinery**, *Paper* on machinery for crushing stone for macadamising roads, 1860, 234.—Cost of machines, 245.—Cost of chilling the rolls, 245.—Cost of re-casting rolls per ton of stone crushed, 245.—Comparative cost of hand and machine crushing, 245.

**MOWBRAY, F. W.**, elected Member, 1857, 55.

**MUDIE, D. C.**, elected Member, 1848, July, 20.

**MUIR, ALFRED**, elected Member, 1873, 25.

**MUIR, ANDREW**, elected Member, 1866, 103.

**MUIR, E.**, elected Member, 1873, 45.

**MUIR, W.**, elected Member, 1863, 113.

**MULLINER, C.**, elected Member, 1872, 254.

**MUNTZ, A.**, Boiler Tubes, best composition depends on quality of coal and water used, 1867, 56.—Ship's bottom fouls if sheathing does not oxidise sufficiently, 57.

**MUNTZ, G. F.**, elected Member, 1857, 232.

**MUNTZ, G. H. M.**, elected Member, 1856, 7.

**MURDOCK, W.**, *Inventions and Life of*, *Paper* on the inventions and the life of William Murdock, by W. Buckle, 1850, Oct., 16.—Early life, 16.—Residence at Soho foundry, 17.—Patent for improvements in steam engine, 17.—Description of original locomotive, 18.—Trial of locomotive, 19.—Use of coal gas for lighting, 20.—Gas retorts, 20.—Boring pipes and columns out of stone, 21.—Compressed-air engines, 22.—Pneumatic bells for houses, 23.—Cast-iron cement, 23.—Steam gun, 23.—Water-heating apparatus, 24.—Death, 25.

*Discussion*.—Buckle, W., 25.—McConnell, J. E., 26.—Middleton, W., 25.—Slate, A., 26.

**MURDOCK, W. M.**, elected Member, 1865, 54.

**MURPHY, J.**, elected Member, 1859, 53.

**Coal Mining**, cost of timbering in South Wales, 1862, 85.

**Tool Holder**, great waste of steel in ordinary tools, 1866, 298.—Importance of grinding tools to correct angle, 299.

**Water Works**, Dublin, importance of abundant supply of water to large towns, 1865, 212.—Constant supply better than intermittent, 213.—Irregularity of rating, 214.

MURRAY, D., elected Member, 1864, 60.

MURRAY, T. H., elected Member, 1858, 80.

MUSGRAVE, J., Jun., elected Member, 1863, 246.

## N.

NAPIER, J., elected Member, 1848, July, 20.—Council, 1872, 25.—Vice-President, 1873, 24.

NAPIER, J. D., elected Member, 1867, 18.

NAPIER, J. M., elected Member, 1870, 19.

NAPIER, R., elected Member, 1856, 250.—President, 1863, 14.—1864, 18.—1865, 19.

Decimal Measure, Inch and Metre, great expense of changing standard, 1865, 51.

Donation of £50, 1863, 57.

Peat Fuel, iron manufactured with peat very superior for axles, 1865, 158.

Steam Dredgers, rise of tide at Glasgow, 1864, 161.

Water Works, Dublin, gravitation system better than pumping, 1865, 208.—

Waste of water chiefly with house supply, 212.

NAPIER, R. T., elected Graduate, 1872, 254.

NASMYTH, J., Axles, iron bar weaker per square inch when outside removed, 1853, 98.

NASMYTH'S GIRDERS. *See* Girders.

NASMYTH'S VENTILATING FAN. *See* Ventilating Fan, 1856, 251.

NATORP, G., elected Member, 1861, 211.

NAYLOR, J. W., elected Member, 1861, 211.

NAYLOR, W., elected Member, 1858, 12.

Boilers, Corrosion of, working pressure should be reduced, 1866, 69.—Strain on lap joints, 70.—No grooving at butt joints, 70.—Punched holes weaker than drilled, 71.—Corrosion above water line, 71.—Tensile strength of plates greater when hot, 76.

Pile Driver, importance of sufficiently heavy ram, 1867, 265.—Destruction of piles with too light ram, 266.

Pumping Engines, heavy shock on closing of valves, 1867, 249.

Riveter, Portable Steam, difficulties in working with a former riveter, 1865, 140.

Safety Valve, *Paper* on Haste's improved safety valve for steam boilers, 1859, 186.

Safety Valve, *Paper* on an improved safety valve for steam-engine boilers, 1865, 220.—Much smaller valve can be used than with ordinary valves, 228.—Trial of valve, 228.—Cost, 231.—Advantage of knife-edged bearing, 232.

NAYLOR, W. (continued).

Steam Hammer, prolonged piston-rod to diminish jar, 1857, 240.—Speed of working, 241.—Facility for changing force of blows, 241.

Steering Engine, Steam, experiment on steering with a small auxiliary screw, 1867, 282.

NEAVE, W. A., elected Associate, 1867, 60.

NEILSON, J. B., Hot-Blast Ovens, early experiments suggesting use of hot blast for blast furnaces, 1859, 98.—Great unwillingness of ironmasters to allow trials of hot blast, 99.—Advantage of hot blast in diminished fluctuation of temperature, and point of fusion brought down nearer to tuyeres, 105.—Hot-blast iron quite equal to cold-blast when fairly compared, 106.—Improved oval oven with core appears the best yet made, 108.

Regenerative Hot-Blast Stoves, advantage in use of hot blast, 1860, 65.—High temperature of blast very desirable, 66.

NEILSON, W. M., elected Member, 1863, 246.—Council, 1865, 19.—1868, 19.

Boiler, *Paper* on an improved locomotive boiler, 1856, 236.

NELSON, J., elected Member, 1869, 77.

NETTLEFOLD, J. H., elected Member, 1860, 53.

NEVILLE, P., Water Works, Dublin, *Paper* on the new Dublin Corporation Water Works for the supply of water from the river Vartry, 1865, 201.

NEWALL, J., elected Member, 1856, 79.

Railway Break, cost of Newall's break, 1853, 164.

NEWALL'S RAILWAY BREAK. *See* Break, Railway, 1853, 158.

NEWCASTLE COLLIERY WORKING. *See* Colliery, Newcastle, 1858, 177.

NEWCASTLE Summer Meetings, 1858, 125.—1860, 119.

NEWCASTLE WATER WORKS ENGINE. *See* Pumping Engine, 1859, 55.

NEWDIGATE, A. L., elected Member, 1866, 18.

NEWELL LOCK. *See* Locks, 1851, June, 16.

NEWTON, W. E., elected Member, 1862, 314.

Cartridge Machinery, disadvantages of rim-fire cartridge, 1868, 127.—Boxer cartridge-case not water-tight, 127.

Corn Mill, Buchholz, loss of nutritive properties by removal of cerealine, 1872, 235.—Close bread containing cerealine more digestible than fine white bread, 239.

Flow of Solids, proposal to convert iron into steel by concussion, 1867, 147.

Peat Fuel, for iron-smelting must be converted into charcoal, 1865, 155.—Preparation of peat for iron-smelting, 156.

Plate Glass Manufacture, dry method of sorting substances according to size of particles, 1863, 222.

Puddling, Mechanical, stirring by forcing gas through molten metal, 1867, 167.

NEWTON, W. E. (continued).

Railway Chair, Bracket, bursting of chairs by expansion of wooden keys obviated by bracket chair, 1873, 255.

Sand-Blast Process, *Paper* on Tilghman's sand-blast process and its application for cutting stone, &c., 1873, 260.—Other applications of sand-blast, 270.—Wood carving, 271.—Minerals harder than quartz can be cut, 271.—Soft steel probably cuts easier than hard, 271.—Interference of particles of sand with one another in boring holes in granite, 271.—Rate of cutting in granite, 272.—Sheet-iron templates for carving marble, durability of, 274.—Application to preparing lithographic stones, metallic plates, &c., 276.—Much cheaper for etching glass than hydrofluoric acid, 276.—Duration and cost of nozzle tubes, 277.—Steam must be dry, 277.

Steam Dredgers, description of American dredgers, 1864, 159.

Water Works, Glasgow, importance of use of meters, 1864, 138.

Ventilation, Mechanical, fresh air should be brought down from above, 1863, 204.

NEWTON'S RAILWAY BREAK. *See* Break, Railway, 1853, 162.

NICHOL, P. D., elected Member, 1853, 266.—Decease, 1872, 2.—Memoir, 20.

NICHOLS, W., elected Honorary Member, 1863, 247.

NIXON, C., elected Member, 1851, July, 45.

NOBLE, A., Capt., Instrument for determining velocity of projectiles in different parts of bore of gun, 1869, 201.

NORFOLK, R., elected Member, 1866, 55.

NORRIS, R. S., elected Member, 1850, Jan., 5.

Railway Chair, *Paper* on an improved railway joint chair, 1853, 101.—Cost and time of casting chairs, 105.—Shifting of rails when expansion not allowed for, 107.

NORRIS, W. G., elected Member, 1868, 43.

NORTH, F. W., elected Member, 1869, 120.

NOTTINGHAM Summer Meeting, 1870, 125.

NUT-SHAPING MACHINE. *See* Shaping Machine, 1869, 312.

NYE, H., elected Member, 1870, 125.

## O.

OASTLER, W., elected Member, 1860, 89.

OATES, J. P., Brick-Making Machine, cost of machine, 1859, 263.—Durability of pugging screw, 263.

OBSERVATORY, *Paper* on a wrought-iron observatory, for maintaining equality of internal and external temperature, by C. C. Walker, 1873, 279.—Necessity of equality of temperature, 279.—Walls must be good conductors, and not store much heat, 279.—Wrought-iron observatory

## OBSERVATORY (continued).

quite successful, 280.—Description of building, 281.—Illustrations of equality of internal and external temperature, 283.—Rapidity of change of temperature inside building, 284.

*Discussion.*—Amos, C. E., 287.—Bird, F., 285, 287.—Paget, A., 288.—

Siemens, C. W., 285, 287, 288.—Walker, C. C., 286, 287, 288.

O'CONNOR, C., elected Member, 1868, 103.

OIL MILL MACHINERY, *Paper* on oil mill machinery, by A. Samuelson, 1858, 27.

—Early forms of oil press, 27.—Crushing rolls, 28.—Edge stones for grinding, 29.—Heating kettle, 30.—Screw press, 31.—Stamper press, 31.—Hydraulic press, 32.—Blundell's hydraulic press, 32.—Oil instead of water for working presses, 33.—Screw press not successful, 34.—Comparative merits of stamper and hydraulic presses, 36.—Extent of manufacture, 37.

*Discussion.*—Bennett, P. D., 40.—Cowper, E. A., 41.—Fothergill, B., 39.—Lloyd, Sampson, 40.—McConnell, J. E., 39.—Samuelson, A., 38, 39, 40, 41, 42.—Whitworth, J., 39, 41, 42.—Williams, R., 40.

OLIVER, W., elected Member, 1866, 264.

OLRICK, L., elected Member, 1867, 60.

Boilers, defective circulation in several boilers, 1871, 247.—Field boiler very compact and successful, 247.

Boiler Explosions, efficient working of boiler with cluster of small vertical tubes over fire, 1866, 176.—Safety-valve to blow off readily, 178.—Purifying water from carbonate of lime before supplying to boiler, 1870, 211.

Condenser, Ejector, Rankine's experiments, 1872, 266.

Governor, Siemens' differential governor best for land engines, 1871, 224.—Silver's four-ball governor best for marine engines, 225.—Crossed-arm governor very successful, 226.—Allen governor, cylindrical throttle-valve great improvement on ordinary disc-valve, 1873, 59.—Governor spindle lubricated by leakage of oil from cylinder, 60.—Illustration of sensitiveness of Siemens governor, 60.

Riveted Joints, formulæ scarcely applicable, 1872, 84.—Designing of joints for steel high-pressure boiler, 85.—Caulking often injurious if pitch of rivets too great, 86.—Diagonal-jointed boiler good, but expensive to make, 87.—Zigzag riveting preferable to chain-riveting, 88.—Difficulty in setting out holes for zigzag riveting, 88.—Friction of rivet heads partly holds plates together, 95.

OMMANNEY, F. F., elected Member, 1864, 271.

Coal-Cutting Machine, mode of fixing cutters, 1872, 220.

ONION, —, Rotary Engine, trial of rotary engine, 1848, July, 4.—Difficulty overcome of packing rotary engine steam-tight, 4.



OPEN COKING. *See* Coking, 1860, 188.

ORE DRESSING, Berdan's crushing and amalgamating machine. *See* Crusher, 1854, 33.

ORE-DRESSING MACHINERY, *Paper* on the mechanical appliances used for dressing tin and copper ores in Cornwall, by H. T. Ferguson, 1873, 119.  
—Copper lodes change to tin at greater depth, 119.—Stuff raised is tipped into slides, 119.—Blake's crusher superseding hand "ragging" in some mines, 119.—Tin dressing, 120.—Specific gravities of impurities, 120.—Stamping, 120.—Husband's pneumatic stamps, 122.—Buddling, 124.—Martin's self-acting buddle, 124.—E. Borlase's concave buddle, 125.—Propeller-knife buddle, 126.—Tossing and packing, 126.—T. Borlase's ore-dressing machine, 127.—Calcining, 128.—Oxland and Hocking's calciner, 128.—Results of dressing, 129.—Treatment of slimes, 130.—Dingey's pulveriser, 131.—Copper-ore dressing, 132.—Crushing, 133.—Jigging, 134.—Collom's jigger, 135.—Sampling, 136.

*Discussion.*—Bolitho, T. S., 146, 149.—Bramwell, F. J., 142, 143, 145, 150.—Cochrane, C., 143.—Ferguson, H. T., 137.—Husband, W., 143, 145, 146, 149.—Lawrence, H., 145.—Maynard, Capt. J., 142, 143.—Taylor, R., 137, 146.

OSBORN, S., elected Member, 1870, 61.

OSLER, A. F., Anemometer, description of, 1852, 91.

OSMAN, J., elected Member, 1870, 228.

OUGHTERSON, G. B., elected Member, 1867, 234.

OUSE RIVER BRIDGE, Hydraulic Swing. *See* Bridge, Hydraulic Swing, 1869, 121.

OVEREND, W., elected Honorary Member, 1848, Apl., 24.

OWEN, W., Original Member, 1847.

## P.

PACKING for Pistons. *See* Piston Packing.

PACKING for Pistons of heated-air engine, 1873, 70.—Of pneumatic stamps, 145.

PACKING for Slide-Valves. *See* Valve Packing, 1856, 61.

PACKING LEATHERS for Hydraulic Machinery, 1872, 191.

PADDON, J., Coke Ovens, importance of coking Staffordshire slack, 1861, 92.—  
New ovens thoroughly successful, 92.—Increase of yield from ovens, 93.  
—Superiority of coke, 93.

PAGET, A., elected Member, 1868, 103.

Knitting Machine, *Paper* on self-acting machinery for knitting hosiery by power, 1870, 127.—Sinkers formerly liable to break, 140.—Manufacture of sinkers and needles, 141.—Manufacture of pitch-chain, 143.—Cast-

PAGET, A. (continued).

iron cams, durability of, 143.—Cost of machine, 144.—Intermediate improvements in knitting machines, 144.

Rules of Institution, alteration, 1873, 251.

PAGET, F. A., Steam Road Roller, saving in cost of metalling due to horse and steam rolling, 1870, 119.—Heavy expense for maintenance of roads in London, 120.

PALMER, A. S., elected Member, 1869, 120.

PALMER, J. B., elected Member, 1847.

PAPERS read during the previous year, 1849, Jan., 4.—1850, Jan., 40.—1851, Jan., 5.—1852, 4.—1853, 5.—1854, 3.—1855, 3.—1856, 3.—1857, 3.—1858, 4.—1859, 4.—1860, 4.—1861, 4.—1862, 4.—1863, 4.—1864, 4.—1865, 4.—1866, 4.—1867, 4.—1868, 4.—1869, 4.—1870, 4.—1871, 4.—1872, 4.—1873, 5.

PAPERS, Subjects for, 1850, Jan., 41.—1851, Jan., 36.—1852, 35.—1853, 40.—1854, 45.—1855, 35.—1856, 43.—1857, 5.—1858, 5.—1859, 5.—1860, 5.—1861, 5.—1862, 7.—1863, 5.—1864, 5.—1865, 5.—1866, 6.—1867, 6.—1868, 6.—1869, 7.—1870, 6.—1871, 6.—1872, 6.—1873, 7.

PAQUIN, J. F., elected Member, 1859, 247.

PARAFFIN for Ship Models, 1873, 203.—Chemical composition of, 214.

PARIS Summer Meeting, 1867, 59.

PARKE, F., elected Member, 1871, 117.

PARKER, F. (Leeds), elected Member, 1868, 103.

PARKER, F. (Louth), Original Member, 1847.

PARKER, H., elected Member, 1868, 43.

PARKER, T. (Derby), elected Member, 1869, 20.

PARKER, T. (Gorton), elected Member, 1872, 26.

PARKES, A., elected Member, 1865, 54.

PARKES, P., elected Member, 1871, 65.

PARKIN, J., elected Member, 1860, 250.

PARKINSON, J., elected Member, 1858, 45.

PARKINSON, W., Water Meter, *Paper* on a water meter, 1851, Jan., 19.

PARRY, D., elected Honorary Member, 1865, 219.

PARSONS, C. T., elected Honorary Member, 1864, 122.

PARTON, T., elected Member, 1866, 18.

PATENTS, communication from Patent Office on creating Commissioners of Patents, 1868, 44.

Memorial to the Lord Chancellor, 1864, 267.

PATON, W., elected Member, 1847.

PATTERSON, J., elected Associate, 1871, 65.

PAXMAN, J. N., elected Member, 1872, 75.

PAYNE, E. J., elected Member, 1853, 8.

Metallic Rods, *Paper* on a new manufacture of compound metallic rods and bars, 1855, 18.—Sand core remains central in rolling, 23.—Increased strength, 23.—Proportion of sand, 24.

Signal, *Paper* on a new railway train signal, 1854, 49.

PEACOCK, RALPH (Goole), elected Member, 1869, 276.

PEACOCK, RALPH (Manchester), elected Member, 1869, 276.

PEACOCK, RICHARD, Original Member, 1847.—Council, 1849, Jan., 9.—1853, 8.

Cambrian Engine, no objection to levers outside in working of locomotive with third shaft between wheels, 1848, Oct., 15.

Locomotive Workshops, *Paper* on the workshops for the locomotive, carriage, and wagon departments of the Manchester, Sheffield, and Lincolnshire railway, 1851, Jan., 22.

Railway Break, cost of re-turning and renewing tyres of wheels with ordinary breaks, 1852, 26.

Station Buffer, shaft might be twisted or broken, 1849, Jan., 13.—Ordinary elliptic-spring buffer very simple and effectual, and recoil prevented by catches, 13.

Steam Hammer, *Paper* on a steam hammer for light forgings, 1860, 284.—Cost of hammer, 287.—Connexion of piston-rod to hammer head, 290.—Catch to prevent hammer rising too high, 292.

Steel Tyres, Banks' tyres answered well in tenders and engines, and great saving in tenders, 1848, Apl., 22.

PEARCE, R., elected Member, 1873, 45.

PEARCE, R. W., elected Member, 1867, 234.

PEARSON, J., elected Member, 1848.

PEARSON, J. E., elected Graduate, 1867, 60.

PEARSON, T. H., elected Graduate, 1870, 61.

PEARSON, W. H., elected Member, 1869, 201.

PEASE, J. B., Iron Manufacture, Hæmatite, cause of failure of high hæmatite blast-furnace, 1871, 141.—High furnaces will probably succeed in hæmatite district, 142.

PEAT FUEL, *Paper* on the manufacture of compressed peat fuel, by C. Hodgson, 1865, 147.—Difficulty of drying peat, 147.—Arrangement of Derrylea works, 148.—Railway and harrow, 149.—Amount of water in peat, 150.—Drying kilns, 151.—Peat presses, 152.—Uses of peat fuel, 153.

*Discussion.*—Ferne, J., 160.—Harman, H. W., 160.—Hodgson, C., 154, 157, 159, 160, 161, 162, 163, 164.—Kennan, J., 160.—Napier, R., 154, 158, 159, 162, 163, 164.—Newton, W. E., 154, 160.—Ramsbottom, J., 162.—Smith, L., 158.—Webb, F. W., 162.—Whitley, J., 164.

PEEL, G., Jun., elected Member, 1866, 265.

PEELE, A. J., elected Member, 1866, 18.

PEET, H., elected Member, 1859, 54.—Decease, 1866, 2.—Memoir, 14.

PENDULOUS ENGINE, *Paper* on the direct conversion of rectilinear into circular motion in the steam engine, by J. A. Shipton, 1851, Oct., 4.—Principle of steam engine not altered since its invention, 5.—Principle of pendulous engine, 6.—Description of engine, 6.—Advantages, 7.

*Discussion.*—Clift, J. E., 8, 9.—Elwell, E., 8.—Shipton, J. A., 8, 9.—Siemens, C. W., 8, 9.—Slate, A., 9.

PENN, J., elected Member, 1848, Apl., 24.—Vice-President, 1850, Jan., 4.—1851, Jan., 8.—1852, 8.—1853, 7.—1854, 5.—1855, 5.—1856, 5.—President, 1858, 12.—1859, 13.—Vice-President, 1860, 13.—1861, 13.—1862, 19.—President, 1867, 17.—1868, 19.

Boiler Construction, flanged plates better than angle irons for riveting to end plates, 1859, 229.—Importance of large water spaces at sides of flue, 229.

Superheated Steam, *Paper* on the application of superheated steam in marine engines, 1859, 195.—Less injection water needed in condenser when steam superheated, 201.—Joints of superheating apparatus thoroughly satisfactory, 201.—Temperature of stoke-hole much reduced by superheating apparatus, 206.

Telegraph Machinery, special safety-valve to prevent undue pressure of steam in engines, 1867, 44.

Wood Bearings, *Paper* on wood bearings for screw propeller shafts, 1856, 24.

Wood Bearings, *Paper* on wood bearings as applied to the shafts of screw steam vessels, 1858, 81.—Failure of metal bearings for screw shafts, 85.—Wood bearings for screw shafts and for end thrust have never failed, 86.—Not advisable for engine bearings, 86.—Rise of temperature of water in tank during experiments, 87.—Not recommended for rolling mills or heavy machine-shafts, 89.

PENN, J., Jun., elected Member, 1873, 250.

PENN, W., elected Member, 1873, 250.

PENZANCE Summer Meeting, 1873, 87.

PERFORATING MACHINE, *Paper* on the multifarious perforating machine, by B. Fothergill, 1848, Jan., 3.—Description of machine, 3.—Jacquard plates and selecting bars for punches, 4.—Traversing frame for plate, 7.—Manner of working, 9.—Machine for perforating thin metal sheets in patterns, 10.—Combined punching and shearing machine, 14.—Employment of perforating machine for Conway tubular bridge, 15.

PERKINS, L., elected Member, 1861, 109.

High-Pressure Steam Engine, *Paper* on a boiler, engine, and surface condenser, for very high-pressure steam with great expansion, 1861, 94.—Pressure of steam in each cylinder, 104.—Cost of engine, 105.—Boiler couplings, 107.

PERKS, J. H., elected Member, 1866, 55.

Condenser, Ejector, working of condenser, 1872, 265.—Fluctuation of vacuum at each discharge of exhaust steam into condenser, 265.

Riveted Joints, increase of strength in diagonal joint, 1872, 83.

PERRAN Iron Lode, 1873, 103, 118.

PERRING, J. S., elected Member, 1856, 79.—Decease, 1870, 2.—Memoir, 15.

PERRY, F. C., Boiler Lining, Whittle's, great success of lining in removing and preventing deposit, 1871, 62.

PERRY, T. J., elected Member, 1863, 246.

PERRY, W., elected Member, 1865, 54.

PETO, S. M., elected Honorary Member, 1848, July, 20.

PETTIFOR, J., elected Honorary Member, 1856, 80.

PEYTON, A., elected Honorary Member, 1864, 122.

PEYTON, E., elected Member, 1860, 53.

PHILIPSON, G. H., elected Member, 1848, July, 20.

PICKERSGILL, T., elected Member, 1869, 276.

PIDGEON, D., elected Member, 1867, 60.

PIGGOTT, G., elected Member, 1856, 7.—Decease, 1872, 2.—Memoir, 20.

Magnetic Water Gauge, *Paper* on Pinel's magnetic water gauge for steam boilers, 1860, 83.

PILE DRIVER, *Paper* on an improved steam pile-driver, by R. Morrison, 1856, 287.—Advantage over hand pile-drivers, 287.—Description of machine, 287.—Mode of working, 288.—Advantages over other machines, 289.

*Discussion.*—Bach, R., 292, 293.—Bunning, T. W., 290, 291, 292, 293.—Hawkes, W., 292.—Humber, W., 291.—Lloyd, Sampson, 290, 291, 292, 293.—Lloyd, Samuel, Jun., 291.—Phillips, J., 291.—Ramsbottom, J., 292.—Shelley, C. P. B., 293.

PILE DRIVER, *Paper* on the theory of pile driving, with description of an improved steam pile-driving machine, by M. Scott and A. J. Robertson, 1857, 12.—Theory of pile driving, general deductions, 12.—Importance of heavy ram, 13.—Height of fall, 14.—Calculation of effective fall of ram in Nasmyth's steam pile-driver, 16.—Description of improved steam pile-driver, 18.—Clutches for disengaging drums, 19.—Spring and air cylinder to prevent shock, 20.—Advantages of steam pile-driver, 22.

*Discussion.*—Fenton, J., 23.—Fothergill, B., 23, 24.—Robertson, A. J., 23, 24.—Whitworth, J., 23, 24.

PILE DRIVER. *Paper* on an improved steam pile-driver with endless chain, by P. B. Eassie, 1867, 255.—Former attachments of lifting chain to ram, 255.—Improved pile-driver, 256.—Follower, 257.—Striker-off, 258.—Endless pitch-chain, 258.—Platform, 259.—Telescopic pile-driver, 260.—Needle, 261.—Cast-iron pile-shoes, 261.—Particulars of working of telescopic pile-driver, 262.



PILE DRIVER (continued).

*Discussion.*—Cowper, E. A., 264.—Eassie, P. B., 263, 265.—Lloyd, Sampson, 263, 266.—Naylor, W., 265.

PILGRIM, T., Superheated Steam, economy from application of superheating to Thames boats, 1860, 36.—Cutting of cylinders probably due to dirt in priming water, 37.

PILKINGTON, R., Jun., elected Member, 1854, 5.

Balanced Valve, saving in wages for working steam hammer with balanced valve, 1857, 193.

Plate Glass Manufacture, uneven surface of plates if annealing oven too hot, 1863, 219.—Great cost of importing foreign sand, 220.

Polished Sheet Glass, *Paper* on the processes and mechanical appliances in the manufacture of polished sheet glass, 1863, 268.—Time required for polishing, 278.

PIM, J., elected Member, 1859, 247.

PIM, W., elected Member, 1848, July, 20.

PINEL'S MAGNETIC WATER GAUGE. *See* Water Gauge, 1860, 83.

PIPE JOINTS, High temperature, 1860, 33.—1873, 82.—Hydraulic machinery, 1858, 143.—1872, 201.—India-rubber, 1848, Oct., 20.

PISTON, *Paper* on an improved piston for steam engines, by J. Ramsbottom, 1854, 70.—Description of piston, 71.—Advantages, 71.—Durability and cost, 72.

*Discussion.*—Chellingworth, T. T., 74.—Everitt, G. A., 73.—Jobson, R., 73.—Mathews, W., 73, 74.—Payne, E. J., 74.—Ramsbottom, J., 73, 74.—Slate, A., 73, 74.

PISTON, *Paper* on an improved wrought-iron piston, by J. E. McConnell, 1854, 119.—Description of piston, 120.—Packing, 120.—Lightness of piston, 120.—Durability, 121.

*Discussion.*—Chellingworth, T. T., 122.—Fairbairn, W., 121, 122.—McConnell, J. E., 121, 122.

PISTON PACKING, *Paper* on a spiral-coil piston-packing, by D. Joy, 1855, 171.—Description of packing and piston, 171.—Pressure on surface of packing, 172.—Experiments, 173.—Facility of renewal, 174.

*Discussion.*—Cowper, E. A., 175.—Fairbairn, W., 174, 175, 176.—Joy, D., 174, 175.—Marshall, W. P., 176.—Ramsbottom, J., 174.

PISTON PACKING, *Paper* on the construction of packing rings for pistons, by J. Ramsbottom, 1855, 206.—Unequal wear of circular rings, 206.—Experiments on form of ring, 206.—Light pressure against cylinder sufficient, 207.

*Discussion.*—Jackson, P. R., 207.—Joy, D., 208.—Ramsbottom, J., 208.

PISTON PACKING, *Paper* on a packing for pistons of steam engines and pumps, by G. M. Miller, 1862, 315.—Packing for locomotive engine pistons, 315.—Joints of ends of packing rings, 316.—Durability of brass and steel

# **PISTON PACKING** (continued).

packing rings, 316.—Packing for stationary engines, 318.—Pump bucket and plunger packings, 319.

*Discussion.*—Beyer, C. F., 324, 325, 326, 327.—Bramwell, F. J., 320, 323, 325, 326.—Fernie, J., 320, 321, 322, 323, 324, 327.—Joy, D., 324.—Miller, G. M., 320, 321, 322, 323, 324, 325, 326, 327.—Wright, J., 325.

**PISTON WATER-METER.** *See* Water Meter, 1856, 151.

**PITTS, J.**, elected Member, 1859, 97.—Decease, 1871, 2.—Memoir, 16.

**PLANT, R.**, elected Member, 1852, 9.

**PLATT, JAMES**, elected Member, 1871, 65.

**PLATT, JOHN**, elected Member, 1859, 248.—Decease, 1873, 2.—Memoir, 19.

Cotton-Spinning Machinery, *Paper* on machinery for the preparing and spinning of cotton, 1866, 199. — Combing machine beginning to supersede carding engine, 243.

**PLATT, S. R.**, elected Member, 1867, 60.

**PLATT, W. W.**, elected Member, 1870, 19.

**PLAYER, J.**, elected Member, 1862, 20.—Decease, 1871, 2.—Memoir, 17.

**PLAYER, J.**, Jun., elected Member, 1869, 77.

**PLOUGHING** by Steam Power. *See* Steam Cultivation, 1857, 57.—1865, 55.

**PLUM, T. E. D.**, elected Member, 1866, 265.

**PLUM, T. W.**, elected Member, 1861, 109.

Ships, Iron, rolling large girders, 1863, 145.

**PNEUMATIC LIFT**, *Paper* on a pneumatic lift, by B. Gibbons, 1849, July, 11.—

Pneumatic lift employed to raise ore, coal, and limestone for charging blast-furnaces, 11.—Ordinary inclined plane objectionable from space occupied, and difficulty in stopping if chain breaks, 12.—Water balance objectionable, because break required to check accelerated velocity in descent, 12.—Pneumatic lift worked by pressure of furnace blast, 13.—Platform on top of air-cylinder prevents risk from breaking of chain, 14.—Mode of working, 15.—Velocity of descent checked by regulating escape valve, 16.—Supply of blast and cost of working, 17.—Economy from use of small power constantly acting, 18.—Platform cannot fall quicker than whole body of air can escape, 18.—Complete control over motion of platform by air valve, 18.

*Discussion.*—Buckle, W., 19.—Beyer, C. F., 19.—Cochrane, A. B., 19.—

Cowper, E. A., 20.—Gibbons, B., 19, 20.—Slate, A., 20.

**PNEUMATIC SIGNAL BELL**, by W. P. Maddison, 1857, 83.

**POLE, W.**, elected Member, 1872, 75.

Cornish Pumping Engines, high degree of expansion in some Cornish engines, 1862, 161.

Double-Cylinder Engines, *Paper* on the double-cylinder expansive steam engine, 1862, 242.—Impossible to carry expansion far in single-cylinder

POLE, W. (continued).

crank engine, 269.—Initial blow on piston, 269.—Limit to degree of expansion, 283.—Duty of double-cylinder engines equal to best Cornish engines, 283.

Iron Armour for Ships, soft iron necessary for armour plates, 1862, 301.—Several thin plates fastened together failed as armour, 302.—Continuous riveting very successful mode of fastening plates, 303.—Wood backing useful in preventing jar and distributing force of blow, 304.—Wood placed outside armour is of very little use, 306.

POLLARD, J., elected Member, 1856, 79.

PONSONBY, E. V., elected Member, 1860, 90.

PORTABLE ENGINE, *Paper* on Cox and Wilson's portable single-acting steam engine, by T. T. Chellingworth, 1853, 69.—Description of engine, 69.—Boiler, 70.—Advantages and applications, 70.—Governor, 71.

*Discussion.*—Chellingworth, T. T., 71, 72.—Cowper, E. A., 72.—Middleton, W., 72.—Slate, A., 72.—Wilson, J. W., 72.

PORTABLE ENGINE much improved in late years, 1873, 184.—Trials in 1872 at Cardiff, 195.—Comparison with beam engines, 167.

*See also* Agricultural, and Mining.

PORTABLE HYDRAULIC RIVETER. *See* Hydraulic Machinery, 1872, 199.

PORTABLE STEAM RIVETER. *See* Riveter, Portable Steam, 1865, 129.

PORTER, C. T., elected Member, 1866, 265.

Allen Engine, *Paper* on the Allen engine and governor, 1868, 50.—Working speed, 76.—Mechanical lubricator, 77.—Adjustment of lead of valves, 77.—Vacuum given by air-pump, 78.—Further points in Allen engine, 79.

PORTER, J. H., elected Member, 1852, 41.

Wrought-Iron Lighthouse, *Paper* on the Buda wrought-iron lighthouse, 1861, 15.—Diagonal trussing transfers weight of staircase and house to outside pillars, 25.—Saving in weight from use of steel framing, 27.—Joints of main pillars, 29.

PORTER, R., elected Member, 1861, 14.

PORTER GOVERNOR. *See* Allen Engine, 1868, 50.

POTTER, W. A., elected Member, 1869, 120.

POTTS, A., Original Member, 1847.

POTTS, B. L. F., elected Member, 1864, 271.

POTTS, J. T., elected Graduate, 1851, July, 45.

POWELL, T., elected Member, 1870, 125.

POWELL, W., elected Member, 1867, 18.

POWER TRANSMISSION, by Compressed Air. *See* Coal-Cutting Machinery, 1868, 135.

—Water Pressure. *See* Hydraulic Machinery, 1868, 21.

—Wire Rope. *See* Craue, 1868, 164.

PRATCHITT, J., elected Member, 1867, 60.

PRATCHITT, W., elected Member, 1865, 218.

PRESERVATION OF TIMBER. *See* Timber, 1851, Oct., 10.—1856, 196.

PRESIDENT, ADDRESS. *See* Address of President.

PRESSURE GAUGE, *Paper* on Bourdon's metallic barometer, indicator, and other applications of the same principle, by C. Cowper, 1852, 141.—Various principles of pressure gauges, 142.—Original discovery of principle of Bourdon's gauge, 142.—Action of flattened bent-tube, 143.—Description of pressure gauge, 145.—Barometer, 147.—Pyrometer, 147.—Brewer's thermometer, 148.—Steam-engine indicator, 148.—Steam engine acting on same principle, 149.

*Discussion.*—Buckle, W., 150.—Cowper, C., 150.—Peacock, R., 150.

PRESSURE GAUGE, *Paper* on an improved pressure gauge for steam and water, by J. E. Clift, 1855, 129.—Principle of Webster's gauge, 129.—Description of gauge, 130.—Index motion, 131.—Extent of motion of plate, 131.—Thicknesses of plates for different pressures, 133.—Modified gauge, 133.—Water-level indicator, 134.

*Discussion.*—Clift, J. E., 134, 137.—Hodge, P. R., 135, 137.—Joy, D., 135.—McConnell, J. E., 134, 135, 136, 137.—Rofe, H., 136.—Shipton, J. A., 135.—Webster, J., 135, 136.

PRESSURE GAUGE, *Paper* on an improved pressure gauge, by J. Inshaw, 1857, 204.—Description of gauge, 204.—Action of gauge, 204.—Adjusting graduation of dial, 205.—Steel pressure-plates, 205.—Special features of gauge, 206.

*Discussion.*—Fairbairn, W., 208, 209, 210.—Ferne, J., 208, 209.—Fothergill, B., 209.—Inshaw, J., 207, 208, 209, 210.

PRESSURE GAUGE, *Paper* on a new steam pressure gauge, by A. Allan, 1859, 179.—Principle and description of compressed-air gauge, 179.—Gauge can be readjusted at any time, 180.—Modified forms of gauge, 181.—Proving apparatus, 182.

*Discussion.*—Allan, A., 182, 183, 184.—Brown, R., 185.—Cowper, E. A., 183.—Fothergill, B., 185.—Longridge, R. B., 183.—Tomlinson, J., 184.

PRESSURE GAUGE, *Paper* on steam pressure gauges, by E. Spon, 1871, 281.—Inaccuracy of most gauges, 281.—Mercurial gauge, 281.—Bourdon gauge, 282.—Schaeffer's corrugated-plate gauge, 283.—Wallis's segmental-plate gauge, 284.—Miller's piston gauge, 284.—Smith's diaphragm gauge, 285.—Silvester's gauge with three springs, 286.—Foster's gauge, 287.—Syphon pipe for pressure gauges, 287.—Points to be aimed at in pressure gauge, 288.

*Discussion.*—Hawksley, T., 290.—Marten, E. B., 289.—Ramsbottom, J., 289, 291.—Spon, E., 288, 289.

PRESTON, F., elected Member, 1856, 250.

PRESTON, R. B., elected Member, 1848, Apl., 24. — Council, 1849, Jan., 9.—1852, 8.—Decease, 1861, 2.

Pump, crank motion preferred to tappet, 1852, 176.—India-rubber valves, 176, 178.

PRICE, J., elected Member, 1866, 265.

PRIDEAUX, T. S., elected Member, 1855, 97.

Furnace Valve, saving in fuel, 1854, 117.—Importance in cooling stoke-holes of ships, 118.—Durability, 119.

PRINTING MACHINE for Bank Notes, *Paper* on the bank-note printing machine at the Bank of Ireland, by T. Grubb, 1865, 166.—Three stages in process of printing, 166.—Description of machine, 167.—Time of taking impression, 167.—Wiping off superfluous ink, 167.—Turning and locking of polygon, 168.—Motion of printing roller, 168.—Inking of plates, 169.—Ink scraper, 171.

*Discussion.*—Grubb, T., 173, 174.—Mallet, R., 176.—Napier, R., 173, 174, 178.

PROJECTILES, VELOCITY, description of Capt. Noble's instrument for determining the velocity of projectiles in different parts of the bore of a gun, 1869, 201.—Mode of rotating the discs, 201.—Speed of rotation, 202.—Induction coils for registering, 203.—Mode of connecting with gun, 203.—Experiments, 204.—Previous instrument with electro-magnets, 205.—Measurement of distances between spots, 205.—Calculation of curves, 206.—Comparison of slow and quick-burning powder, 206.

PROOF OF GUNS by Measurement. *See* Guns, Proof of, 1866, 105.

PROPELLER, SCREW. *See* Screw-Propeller, 1852, 163.

PUDDLING, MECHANICAL, *Paper* on puddling iron by machinery, by H. Bennett, 1864, 298.—Objects aimed at in applying machinery to puddling, 298.—Description of mechanism for working the rabble, 299.—Mode of working, 301.—Consumption of coal, and yield of iron, 302.

*Discussion.*—Barker, P., 303.—Beard, G., 307.—Cowper, E. A., 303, 305, 309.—Fisher, W., 303, 305, 306, 308.—Lloyd, Sampson, 305.—Mathews, W., 306.—Maudslay, H., 303.—Smith, F., 305.

PUDDLING, MECHANICAL, *Paper* on mechanical puddling, by W. Menelaus, 1867, 151.—Different plans of mechanical puddling, 151.—Experimental vessel, 152.—Trial forge with four vessels, 153.—Linings, 155.—Results very uniform, but quality not satisfactory, 157.

*Discussion.*—Bell, I. L., 165.—Bramwell, F. J., 160.—Clay, W., 168.—Cochrane, C., 169.—Menelaus, W., 158, 160, 162, 165, 167, 168, 169, 170.—Neilson, W. M., 171.—Newton, W. E., 167, 169.—Penn, J., 158, 162, 165, 169, 170, 172.—Richards, E. W., 163.—Riley, E., 164, 171.—Siemens, C. W., 158.—Webb, F. W., 171.—Williams, E., 162, 165, 171.



**PUMP, CENTRIFUGAL**, *Paper* on the mathematical principles involved in the centrifugal pump, by A. J. Robertson, 1852, 99.—General construction, 100.—Calculation of force to produce flow, 100.—Velocity and amount of discharge, 101.—Power required, 102.—Waste of power, 104.—Percentage of useful effect, 105.

*Discussion.*—Bishop, 107.—Buckle, W., 106, 108.—Cowper, E. A., 107.—Crampton, T. R., 108.—Edwards, J., 108.—Grissell, H., 107.—McConnell, J. E., 108.—Phipps, G. H., 106, 107.—Stein, 106, 107.

**PUMP, CENTRIFUGAL**, *Supplementary Paper* on the mathematical principles involved in the centrifugal pump, by A. J. Robertson, 1852, 153.—Limit of useful effect, 153.—Calculations from experiments on Gwynne's pump, 154.

*Discussion.*—Appold, J. G., 155, 157, 159, 160, 162.—Clift, J. E., 157, 163.—Elwell, E., 162.—Gibbons, B., 159, 160, 161.—Whitworth, J., 155, 162.

**PUMP, CENTRIFUGAL**, *Supplementary Paper* on the mathematical principles involved in the centrifugal pump, by A. J. Robertson, 1853, 165.—Advantage of curved arms, 165.—General construction of pump, 166.—Calculation of amount of force to produce flow, 167.—Proper curvature of arm, 170.—Variation in effect with varying height of lift, 171.—Variation in sectional area of arm, 172.—Effect of shape of discharging orifice, 173.

**PUMP, DIRECT-ACTING**, *Paper* on a new direct-acting steam pump, by W. K. Whytehead, 1852, 174.—Description of pump, 174.—Particulars of working, 175.

*Discussion.*—Adams, W. A., 177.—Appold, J. G., 176, 177.—Clift, J. E., 177.—Gibbons, B., 177.—Lloyd, Sampson, 177.—Marshall, W. P., 176.—Middleton, W., 176.—Preston, R. B., 176, 178.—Ramsbottom, J., 175, 176.—Whitworth, J., 178.—Wright, H., 177.

**PUMP, HORIZONTAL V**, *Paper* on a horizontal V pump, by J. J. Birckel, 1864, 33.—Description of pump, 33.—Advantages, 35.—Loss by friction, 36.

*Discussion.*—Birckel, J. J., 37, 38, 39, 40, 41, 42, 43.—Bramwell, F. J., 39.—Cowper, E. A., 43.—Humphrys, E., 41, 42.—Maudslay, H., 40.—Napier, R., 37, 38, 42, 43.—Penn, J., 41.—Wilson, J. C., 42.—Woods, H., 40.

**PUMP VALVES**, *Paper* on improvements in pump valves, by J. Hosking, 1858, 249.—Double-beat valve, 249.—Various other valves, 250.—Gill valve with area of discharge greater than area of supply pipe, 250.—Pyramidal valve with india-rubber rings, 251.—India-rubber ball-valve, 251.—Application to pump buckets, 252.

*Discussion.*—Armstrong, W. G., 254, 255.—Cowper, E. A., 254.—Fothergill, B., 253.—Hosking, J., 253, 254.—Prideaux, T. S., 253.

**PUMPING ENGINES**, *Paper* on the new pumping engines at the Birmingham Water Works, by W. S. Garland, 1853, 110.—General arrangement of

## PUMPING ENGINES (continued).

engines, 110.—Description of engines, 111.—Regulating throttle-valve, 111. — Pumps, 112. — Air vessels, 113. — Beam, 113. — Amount of water pumped, 114.

*Discussion.*—Beyer, C. F., 115, 116. — Cowper, C., 114, 115, 116. — Garland, W. S., 114, 115, 116.—Ramsbottom, J., 114, 115.

PUMPING ENGINES, *Paper* on a new construction of pumping engine, by W. Fairbairn, 1855, 177.—Cornish pumping engine, 178.—Description of new engine with beams below, 179.—Pumps, 180.—Arrangement in shaft, 181.

*Discussion.*—Beyer, C. F., 182.—Neale, 182.—Ramsbottom, J., 182.—Siemens, C. W., 182.

PUMPING ENGINES, *Paper* on the pumping engines of the Wolverhampton Water Works, with some remarks on water pumping, by H. J. Marten, 1856, 7. — Direct-acting engines at Tettenhall, 7. — Sand covering for boilers, 8.—Wood beats for pump valves, 9.—Area of steam valves, 9.—Speed of working, and duty, 10.—Beam engine at Goldthorn Hill, 10.—Boilers and steam pipes, 10. — Pumps and valves, 11. — Stand-pipe for pumping through, 12.—Double-beat valve, 13.—Hosking's ball-valve, 14.—Advantage of beam engine for pumping, 15.—Temporary pumping engine, 17.

*Discussion.*—Fairbairn, W., 19, 20, 21, 22, 23, 24.—Fenton, J., 20, 22, 23.—Garland, W. S., 21.—Marten, H. J., 19, 20, 21, 22.—Wright, H., 23.

PUMPING ENGINES, *Paper* on two pair of horizontal pumping engines, by E. A. Cowper, 1858, 46.—Crank engine gives greater regularity in flow of water than Cornish engine, 47.—Advantage of heavy beam to pumping engine, 48.—Description of pumping engines at Crystal Palace, 49.—Pump valves, 50.—Pumping engines with very long suction-pipe, and stand-pipe, 51.—Indicator diagrams, 51.—Slide-valves, and cam valve-motion, 52.—Pumping engines at Yarmouth Water Works, 53.—Pump valves, 54.—Consumption of coal; indicator diagrams, 55.

*Discussion.*—Brown, J., 60.—Cowper, E. A., 56, 57, 59, 60, 61.—Garland, W. S., 56, 61, 62.—Lloyd, Samuel, 61.—Maudslay, H., 59, 60, 61, 62.—Muntz, G. F., 57, 60.—Siemens, C. W., 57.

PUMPING ENGINES, *Paper* on the pumping engine at the Newcastle Water Works, by R. Morrison, 1859, 55.—Locality and arrangement of reservoirs, mains, filter beds, &c., 55.—Pumping engine to supply higher parts of town, 56.—Pump valves, 56.—Expansion slide, 57.—Special two-way cock for starting engine, 57.—Boilers, 57.—Indicator diagrams, 58.

*Discussion.*—Cochrane, A. B., 60.—Ferne, J., 60.—Marshall, W. P., 59.—Marten, H. J., 59.—Maudslay, H., 58, 59, 61.—Smith, W., 60.

**PUMPING ENGINES, *Paper*** on the Crossness pumping engines for the Metropolitan Main Drainage Works, by G. Hamilton, 1867, 236.—Position of pumping station, 236.—Reservoir, 236.—Pumps, 237.—Arrangement of pumping, 238.—Pumping engines, 239.—Valve cams, 240.—Indicator diagrams, 240.—Details of trials, 241.—Boilers, 241.—Amount of pumping per day, 241.

*Discussion.*—Bramwell, F. J., 243.—Cowper, E. A., 250.—Gray, J. M. F., 243, 247, 248, 252.—Hamilton, G., 242, 243, 246, 253, 254.—Lloyd, Sampson, 242, 254.—Naylor, W., 249.—Siemens, C. W., 248.—Walker, B. P., 254.

**PUMPING ENGINES, CORNISH, *Paper*** on the relations of power and effect in Cornish pumping engines over long periods of working, by C. Greaves, 1862, 147.—Description of engines at East London Water Works, 147.—Working speed, 149.—Different degrees of expansion, 150.—Diagram of valve-motion, 151.—Consumption of feed water per stroke, 153.—Actual final expansion, 154.—Difference between theoretical and actual final expansion, 155.—Theoretical minimum consumption of fuel, 157.—Reasons for not obtaining full power of steam, 157.

*Discussion.*—Adamson, D., 162.—Bramwell, F. J., 161.—Cowper, E. A., 162, 167.—Ferne, J., 165.—Greaves, C., 158, 160, 161, 165, 167.—Hawksley, T., 165, 167.—Howe, W., 166, 167.—Pole, W., 160, 161.—Reynolds, E., 167.—Siemens, C. W., 165.—Slaughter, E., 167.

**PUMPING ENGINES, CORNISH, *Paper*** on the Cornish pumping engine with wrought-iron beam, and the pit work at Clay Cross Colliery, by W. Howe, 1863, 248.—Extent of colliery, 248.—Engine and engine-house, 249.—Foundations, 250.—Cylinder covering, 250.—Tappet-rods, valves, &c., 251.—Wrought-iron beam, 251.—Starting and working of engine, 253.—Boilers, 254.—Bucket pump, 254.—Bucket spears, 255.—Plunger pumps, 256.—Rising main, and spears, 257.—Girders and banging-beams, 258.—Valves in rising main, 259.—Indicator diagrams, 260.—Work done by engine, 261.

*Discussion.*—Bramwell, F. J., 262, 263.—Cowper, E. A., 264, 265, 267.—Ferne, J., 264, 265, 266.—Howe, W., 262, 264, 265, 266.—Lloyd, Sampson, 262, 265, 266, 267.—Warham, J. R., 264.—Webb, F. W., 267.

**PUNCH, HYDRAULIC.** See Hydraulic Shearing Press, 1858, 70.—Hydraulic Shears and Punch, 1862, 341.

**PURVES, J.**, elected Member, 1869, 77.

**PUTNAM, W.**, elected Member, 1866, 265.

**PYROMETER, *Paper*** on a new mode of measuring high temperatures, by J. Wilson, 1852, 53.—Wedgwood's pyrometer, 53.—Daniell's pyrometer, 53.—Air pyrometer, 54.—Description of new pyrometer, 55.—Corrections to be made, 56.—Table of melting points of various substances, 57.

## PYROMETER (continued).

*Discussion.*—Clift, J. E., 59.—Stephenson, R., 58, 59, 60.—Wilson, J., 58, 59.

*See also* Hot-Blast Stoves, Regenerative, 1860, 59, 64.—Blast Furnaces, Cleveland, 1864, 257.

## Q.

QUICKSILVER ENGINE, Howard's, 1870, 218.

## R.

RADCLIFFE, A. H. W., elected Member, 1873, 46.

RADCLIFFE, W., elected Member, 1870, 126.

RADFORD, J., Original Member, 1847.—Council, 1847.

RAFAREL, F. W., elected Member, 1868, 103.

RAILS, Steel, much weakened by bolt hole, 1873, 256.—Wrought-iron, not much injured by hole, 256.

*See also* Steel Rails and Armour Plates, 1861, 121.

RAILWAY AXLES. *See* Axles.

RAILWAY AXLE Lubrication. *See* Lubrication, 1853, 57.—Axlebox.

RAILWAY AXLEBOX and Crossing. *See* Axlebox, 1852, 213.

RAILWAY AXLEBOX and Spring Fittings. *See* Axlebox, 1855, 182.

RAILWAY BREAK. *See* Break.

RAILWAY BRIDGE. *See* Bridge, 1861, 171.—1863, 16.—1869, 121.

RAILWAY BRIDGE PIERS. *See* Bridge Piers, 1863, 16.

RAILWAY BUFFER. *See* Buffer.

RAILWAY CARRIAGES, *Paper* on the saving of dead weight in passenger trains, by C. Fay, 1857, 149.—Comparison of railway carriage with stage coach, 149.—Saving in dead weight with large carriages, 150.—Advantages of long over short carriages, 150.—Objections to carrying luggage on roof of carriage, 152.—Carriage with luggage compartment at each end, 153.—Tension bars for long carriages, 154.—Axle guards, 155.—Framing of coach bodies, 155.

*Discussion.*—Brogden, H., 159.—Fairbairn, W., 158, 160.—Fay, C., 157, 158, 159, 160.—Lloyd, Samuel, Jun., 159.—McCounell, J. E., 156.—Slater, I., 158, 160.—Whitworth, J., 157, 161.—Woodhouse, H., 159.—Wright, J., Jun., 160.

RAILWAY CARRIAGE ELEVATOR, *Paper* on a railway carriage elevator, by W. L. Kinmond, 1848, Oct., 17.—Elevator employed to raise and lower railway wagons at Glasgow terminus, 17.—Platform moved by four shafts with

## RAILWAY CARRIAGE ELEVATOR (continued).

screws working in circular racks, 18.—Racks revolve with screws, saving much friction, 18.—Self-acting disengagement at top, 18.—Friction break to control speed of descent, 18.

*Discussion.*—Crampton, T. R., 19.—Hoby, J. W., 19.—McConnell, J. E., 19.—Slate, A., 19.

RAILWAY CARRYING STOCK, *Paper* on railway carrying stock, by W. A. Adams, 1850, Oct., 26.—Great weight of modern carriages and wagons, 26.—Wagons and carriages constructed only for strength and durability, 27.—Weight of road vehicles, 28.—Tramway rails and wagon, 29.—Destructive action of locomotives on horse tramway, 30.—Horse carriage for short branch lines, 31.—Increase of dead weight in carriages and wagons, 32.

*Discussion.*—McConnell, J. E., 33.

RAILWAY CARRYING STOCK, *Paper* on the improvement of the construction of railway carrying stock, by W. A. Adams, 1851, Jan., 10.—Increase of dead weight, 10.—Differences between railway and road vehicles, 11.—Sole bars, 11.—Experiments on iron sole bars compared with wood, 12.—Difficulty of obtaining well-seasoned oak, 14.

*Discussion.*—Adams, W. A., 16, 17.—Allan, A., 16.—Barrans, J., 16.—Clift, J. E., 18.—Cowper, E. A., 16, 17.—Dockray, R. B., 15.—Gibbons, B., 18.—Henson, H. H., 19.—Jones, E., 15.—Selby, G., 16.—Slate, A., 15, 17, 18.—Thorneycroft, T., 15.—Wright, H., 16, 18.

RAILWAY CHAIRS, *Paper* on an improved mode of moulding chairs, by E. A. Cowper, 1851, July, 42.—Description of mode of moulding, 42.—Chill plates, 43.

*Discussion.*—Cowper, E. A., 44.—McConnell, J. E., 45.—Middleton, W., 44.—Slate, A., 44.

RAILWAY CHAIRS, *Paper* on an improved railway chair, by J. McConochie, 1853, 9.—Description of improved chair, 9.—Safety of rail not dependent on key, 10.—Joint chair, 11.—Bearing surface of rail on chair, 12.—Advantages of improved chairs, 13.—Particulars of experiments, 14.—Lateral deflection of rails, 15.

*Discussion.*—Cowper, E. A., 17.—Fothergill, B., 16.—Lloyd, Samuel, 18.—McConnell, J. E., 15, 16, 17, 18.—McConochie, J., 15, 16, 17, 18.—Stephenson, R., 16, 17, 18.—Williams, R., 18.

RAILWAY CHAIRS, *Paper* on an improved railway joint chair, by R. S. Norris, 1853, 101.—Casting chairs on rails when laid, 101.—Operation of casting, 102.—Portable cupola, 103.—Casting iron keys into ordinary chairs, 104.

*Discussion.*—Blackwell, S. H., 104, 105, 107, 108.—Cowper, C., 107.—Duclos de Boussois, E., 108.—May, C., 106, 107.—Nasmyth, J., 106.—Norris, R. S., 104, 105, 106, 107, 108.—Slate, A., 105.—Woodhouse, H., 104, 105, 107, 108.



RAILWAY CHAIRS, *Paper* on the bracket chairs for suspending double-headed rails on the West Cornwall Railway, by J. D. Sheriff, 1873, 252.—Rails cannot be turned with ordinary chairs, 252.—Bracket chair in two halves with bolt passing through rail, 253.—Railways using the bracket chair, 253.—Duration of chairs, 253.—Bracket chairs considerably lighter and cheaper than ordinary chairs, 254.

*Discussion.*—Amos, C. E., 255, 256, 257.—Halpin, D., 256, 258.—Newton, W. E., 255.—Siemens, C. W., 255, 256, 258.—Walker, C. C., 256, 257.

RAILWAY CHAIRS, burst by expansion of wood keys when wet, 1873, 255.

RAILWAY CHAIRS and Switches, *Paper* on improved railway chairs and switches, by W. Baines, 1849, Jan., 21.—Joint chair prevents joints rising and rails driving forwards, 21.—Rail fixed by dowel-pin through notch cut in end, 21.—Stiffness of joint causes one rail end to support the other, 23.—Intermediate chair fixes rail without use of key by gripping between oblique jaws, 23.—Switch with tongue deeper than main rail, and flange entire at bottom, 24.—Improved lever-box and rod, 24.

*Discussion.*—Hodge, P. R., 25.—McConnell, J. E., 25.

*Adjourned Discussion*, 1849, Apl.—Baines, W., 4, 5, 6, 7.—McConnell, J. E., 6.—Stephenson, R., 5, 6, 7.—Woodhouse, H., 6.

RAILWAY COUPLING. *See* Buffer, 1856, 173.—Safety Wagon Coupling, 1860, 277.

RAILWAY CROSSING, *Paper* on an improved construction of crossing, by H. Woodhouse, 1856, 35.—Wear of wing rails, 35.—Description of improved crossing, 35.—Advantage in turning worn rails, 36.

*Discussion.*—Fairbairn, W., 36, 37.—Lloyd, Sampson, 36.—Woodhouse, H., 36, 37.

RAILWAY CROSSING. *See also* Axlebox and Crossing, 1852, 213.—Railway Signal, 1873, 31.

RAILWAY ECONOMY, *Paper* on the economy of railway transit, by J. Samuel, 1849, Oct., 4.—Locomotives generally much too heavy for number of passengers conveyed, 4.—Average results of working on Eastern Counties line, 4.—Small combined engine and carriage for light branch traffic, 5.—Small consumption of coke, 6.—Light steam carriage best adapted for larger portion of branch traffic, 6.—Small weight on wheels reduces permanent-way repairs, 7.—With heavy engines, impracticable to maintain road in required condition, 8.

*Discussion.*—Adams, W. A., 10.—McConnell, J. E., 9, 11.—Samuel, J., 8, 10, 11, 13.—Slate, A., 11.—Stephenson, R., 8, 11, 13.

RAILWAY, LICKEY INCLINE, working of, 1863, 111.

RAILWAY, PERMANENT WAY, *Paper* on the construction of permanent way, by J. W. Hoby, 1849, Apl., 21.—Rapid deterioration of permanent way from

## RAILWAY, PERMANENT WAY (continued).

increased weight of locomotives, 21.—Expensive first construction may be cheapest from costing little in maintenance, 21.—Required conditions of stability and efficiency, 22.—Comparison of bearing surface on ballast in different constructions of railway, 22.—Bearing surface of rails, 24.—Cross ties and side stiffness, 25.—Stone blocks and wood sleepers, 25.—Longitudinal bearers and cross sleepers, 27.—Form and size of rails, 27.—Rapid deterioration of rails from heavy weight on small surface, 28.—Preservation of timber from decay, 29.—Wood and iron keys for chairs, 30.

*Discussion.*—McCounell, J. E., 31.—Stephenson, R., 30, 31.—Woodhouse, H., 31.

RAILWAY SAFETY BUFFER. *See* Buffer, 1848, Apl., 15.

RAILWAY SAFETY WAGON COUPLING, *Paper* on a new safety coupling for railway wagons, by C. Markham, 1860, 277.—Danger of ordinary mode of shunting, 277.—Description of safety coupling, 278.—Lifting lever, 278.—General advantages, 279.—Experiments on efficiency of coupling, 280.—Table of projection of buffers beyond drawhooks on various railways, 281.—Comparative cost of ordinary and safety coupling, 281.

*Discussion.*—Markham, C., 282.—Maudslay, H., 282, 283.—Wright, J., 282.

RAILWAY SIGNAL, *Paper* on a new railway train signal, by E. J. Payne, 1854, 49.—Various plans tried, 50.—Description of new signal, 51.—Mode of action, 52.—Coupling between carriages, 53.

*Discussion.*—Bird, A., 54, 55, 56.—Clift, J. E., 56.—Jobson, R., 56.—Maher, M., 55.—Mathews, W., 56.—Slate, A., 54, 55, 57.—Woodhouse, H., 55.

RAILWAY SIGNAL, *Paper* on improved apparatus for working and interlocking railway signals and points, by W. Baines, 1873, 31.—Object of interlocking, 31.—General arrangement for a junction, 31.—Interlocking arrangement, 32.—Principle of locking the detents, 34.—Description of apparatus, 35.—No strain on locking gear, 36.—Illustration of a complicated junction, 36.—Rockers easily removed and replaced, 37.—Changes of length in connecting wires, usual adjustment imperfect, 38.—Self-acting compensating apparatus, 39.

*Discussion.*—Baines, W., 40, 41, 42, 43.—Cowper, E. A., 41, 42, 43.—Ramsbottom, J., 41.—Siemens, C. W., 42, 43.—Tweddell, R. H., 42.—Webb, F. W., 41.

RAILWAY SPRINGS. *See* Springs.

RAILWAY STATION ROOF, Birmingham. *See* Roof, 1854, 79.

RAILWAY SWITCH, *Paper* on an improved railway switch, by J. A. Haswell, 1858, 171.—Defects of ordinary sliding switches, 171.—Description of

## RAILWAY SWITCH (continued).

improved switch, 171.—No oil required, 172.—Safety and convenience, 172.

*Discussion.*—Bouch, W., 174.—Bourne, J., 173, 174.—Cowper, E. A., 174.—Haswell, J. A., 173, 174.—Tomlinson, J., 175.—Whitworth, J., 174, 175.

RAILWAY SWITCH. *See* Axlebox and Crossing, 1852, 213.—Railway Chairs and Switches, 1849, Jan., 21.—Railway Crossing, 1856, 35.—Railway Signal, 1873, 31.

RAILWAY TRAIN SIGNAL. *See* Signal, 1854, 49.

RAILWAY WAGONS, *Paper* on improvements in the construction of railway wagons, by H. H. Henson, 1851, July, 3.—Importance of uniformity throughout railway system, 4.—Original goods wagon, 4.—Crib-rails, 5.—Improved open goods wagon, 5.—Tarpaulings, 6.—New covered goods wagon, 7.—Protection from fire, 10.—Danger of rotten floors, 12.—Construction of roof, 13.—Sliding roof and doors, 14.—Modifications of covered wagon, 15.—Saving in dead weight and in cost of maintenance, &c., 16.

*Discussion.*—Adams, W. A., 19.—Cowper, E. A., 19.—Henson, H. H., 17, 18.—McConnell, J. E., 19, 20.—Slate, A., 17, 18, 19.—Smith, W., 18, 19.

RAILWAY WAGONS, *Paper* on improvements in the construction and materials of railway wagons, by W. A. Adams, 1852, 206.—Wagons with wood frames most durable, 206.—Description of improved wagon with iron frame, 207.—Construction of ordinary wood-framed wagon, 209.—Advantages of iron frame, 210.

*Discussion.*—Adams, W. A., 211, 212.—Jones, E., 211.—McConnell, J. E., 210.—Slate, A., 212.—Stephenson, R., 211, 212.—Wright, H., 211, 212.

RAILWAY WAGON COUPLING. *See* Railway Safety Wagon Coupling, 1860, 277.

RAILWAY WHEEL TYRES. *See* Steel Tyres, 1848, Apl., 21.—1866, 186.

RAKE, A. S., elected Member, 1862, 314.—Decease, 1872, 2.—Memoir, 21.

RAMAGE, R., elected Member, 1864, 121.

RAMSBOTTOM, J., Original Member, 1847.—Council, 1849, Jan., 9.—1852, 8.—Vice-President, 1854, 5.—Council, 1855, 5.—1856, 6.—Vice-President, 1857, 11.—1858, 12.—1859, 13.—1861, 13.—1862, 19.—1863, 14.—1864, 18.—1865, 19.—1866, 16.—1867, 17.—1868, 19.—1869, 12.—President, 1870, 18.—1871, 20.

Axles, error in proportion shown by breakage, 1850, Oct., 13.—Mode of finding strain on each part of axle, 14.—Axles should be more tapered in middle, 14.

Boilers, several separate small water spaces necessary for high-pressure boilers, 1871, 253.—Root's boiler appears likely to succeed, 254.

## RAMSBOTTOM, J. (continued).

- Boiler Lining, considerable economy due to boiler plates being kept clean, 1871, 62.—Sulphate of lime more troublesome deposit than carbonate, 63.
- Counter-pressure Steam Break, non-working of injectors when running reversed due to air pumped into boiler, 1870, 51.—Impure water liable to injure cylinder, 52.—Counter-pressure applicable to steep inclines, 52.—Necessity for balanced valves and screw reversing-gear, 53.—Excess over boiler pressure due to momentum of steam, 53.
- Crane, Coking, *Paper* on an improved coking crane for supplying locomotive engines, 1853, 122.
- Crane, Traversing, *Paper* on the improved traversing cranes at Crewe Locomotive Works, 1864, 44.—Importance of properly balancing the pulleys, 55.—Saving from use of cranes, 56.—Success of cotton cord, 56.—Experiments on friction of crab, 57.
- Engine Counter, construction of counter proposed for locomotive, 1849, Jan., 15.
- Flow of Solids, blows not heavy enough to penetrate to centre of mass in ordinary forging, 1867, 144.—Importance of a graduated succession of dies for stamping, 144.
- Hammer, Steam, Horizontal Duplex, *Paper* on a thirty-ton horizontal duplex hammer, 1867, 218.—Importance of heavy hammers, 227.—Rapid working of horizontal hammer, 228.
- Locomotive Boiler, *Paper* on an improved locomotive boiler, 1849, July, 3.
- Locomotive, Distribution of Weight, no advantage in compensating lever except on uneven road, 1864, 118.
- Locomotive Water Supply, *Paper* on a method of supplying water to locomotive tenders whilst running, 1861, 43.—Lowering scoop into trough, 51.
- Marine Engines, advantages from high pressure and early cut-off, 1872, 179.—Trial trips not of much value for results of working, 180.
- Piston, *Paper* on an improved piston for steam engines, 1854, 70.—Economy in consumption of fuel, 73.—Lightness of piston, 73.
- Piston Packing, *Paper* on the construction of packing rings for pistons, 1855, 206.
- Pressure Gauges, advantages of volute spring, 1871, 291.—Rack and pinion better mode of actuating index than spiral groove and pin, 292.
- Railway Axles, axle broken crystalline at journal but fibrous within wheel, 1849, Oct., 24.
- Rifles, Breech-Loading, Martini rifle has many mechanical defects, 1871, 295.—Soper rifle decidedly advantageous, 296.
- Rolling Mill, Reversing, *Paper* on an improved reversing rolling mill, 1866, 115.—Humouring the plates, 121.—Levers for entering slabs into rolls,

## RAMSBOTTOM, J. (continued).

121.—Hydraulic tightening-down gear, 122.—Direct-working engine more economical than one with flywheel, 123.—Steel not injured by rolling both ways, 125.—No trouble from tightening-down screws being geared together, 127.

Safety Buffer, ordinary buffers act in succession through long total space in arresting motion of train, 1848, Apl., 20.

Safety Escape Pipe, *Paper* on a safety escape pipe for steam boilers, 1857, 179.

Safety Valve, *Paper* on an improved safety valve, 1856, 37.

Slide Valve, Balanced, pressure on valve faces when running without steam, 1871, 46.—Double-port valve not applicable to locomotives, 46.

Steam Engine, outside-cylinder locomotives greater priming than inside-cylinder, because of condensation, 1855, 205.

Steel Tyres, Manufacture of, *Paper* on an improved mode of manufacture of steel tyres, 1866, 186.—Securing tyre to wheel, 195.—Success of tyres under severe tests, 195.—Uniformity of Bessemer steel, 197.—Importance of toughness in boiler and other plates, 197.

Surface Condensers, pitting of boilers using very pure peat water, 1863, 156.

Ventilating Fan, *Paper* on the mechanical ventilation of the Liverpool passenger tunnel on the London and North Western Railway, 1871, 22.—Desirable to get natural ventilation when fan not working, 30.—Vibration and noise if fan runs too close to casing, 34.

Ventilating Fan, *Supplementary Paper* on the mechanical ventilation of the Liverpool passenger tunnel on the London and North Western Railway, 1871, 66.—Small discharge round concentric portion of fan case, 68.—Comparison with Guibal fan, 69.—Case should be spiral for a certain portion of circumference, 70.—Radial blades better than curved backwards, 72.—Motion of trains does not much assist ventilation, 74.

RAMSDEN, Sir J., elected Member, 1866, 265.

RANDOLPH, C., Compressed-Air Engine, *Paper* on a compressed-air engine at Govan Colliery, 1856, 145.—Temperature of air in main column, 148.—Successful working of compressing engine, 148.

RANKINE, W. J. M., elected Member, 1872, 75.—Decease, 1873, 2.—Memoir, 21.—Notice by President, 22.

Boiler, failure of firebox with flat top, 1856, 238.

Evaporating Power of Tubes, experiments showing copper to be slightly superior to iron, 1857, 122.

Feed-Pipe Connexion, durability of india-rubber at very high temperature, if not disturbed, 1857, 102.

Water Meter, reaction meters more accurate than piston meters, 1856, 245.—Wheelwork should be protected from water, 245.



RANSOME, A., Jun., elected Member, 1860, 90.

RANSOME, R. C., elected Member, 1869, 120.

RANSOME, R. J., elected Member, 1862, 20.

RAPIER, R. C., elected Member, 1873, 88.

RATCLIFF, C., elected Honorary Member, 1861, 14.

RATCLIFF, D. R., elected Member, 1867, 18.

RATCLIFF, J. F., elected Graduate, 1873, 25.

RATLIFFE, G., elected Member, 1867, 18.

RAVENHILL, J. R., elected Member, 1862, 93.

RAWLINS, J., elected Member, 1872, 26.

RECIPROCATING ENGINE, *Paper* on a new reciprocating steam engine, by J. A. Shipton, 1850, July, 26.—Improvements intended in new engine, 27.—Analogy to piston and crank engine, 28.—Description of engine, 29.—Steam valve, 31.

*Discussion.*—Cowper, C., 34.—Davies, I., 35.—McConnell, J. E., 32, 35.—Robinson, H., 33, 34, 35.—Shipton, J. A., 32, 33, 34.—Simpson, J., 32, 34.—Slate, A., 33, 34.—Smith, W., 33, 34.

REED, E. J., elected Member, 1870, 61.

Iron Armour for Ships, wooden ships can be plated and made serviceable, 1862, 310.—Soft iron necessary for armour plates, 310.

REEVES, C., elected Member, 1856, 250.

REGENERATIVE CONDENSER, *Paper* on a new regenerative condenser for high-pressure and low-pressure steam engines, by C. W. Siemens, 1851, July, 20.—Elastic force of steam at various temperatures, 21.—Description of regenerative condenser, 21.—Action, 22.—Condensing water heated to nearly boiling point, 23.—Little condensing water used, 24.—Advantages for high-pressure engines, 24.—Application to locomotives, 27.—Application to low-pressure engines, 28.—History of condenser, 29.—Thickness of copper plate scarcely affects conduction of heat, 32.—Injection condenser, 33.—Regenerative engine, 34.—Table of pressure of water vapour at various temperatures, 34.

*Discussion.*—Cowper, E. A., 36.—McConnell, J. E., 35, 36.—Siemens, C. W., 35, 36.—Slate, A., 35.—Wright, H., 35.

REGENERATIVE FURNACE, *Paper* on a new construction of furnace, particularly applicable where intense heat is required, by C. W. Siemens, 1857, 103.—Great waste of heat in ordinary furnaces, &c., 103.—Description of regenerative furnace, 104.—Large saving in fuel, 104.—Intense heat obtained, 105.—Application to steel melting, 105.—Puddling furnace, 106.

*Discussion.*—Atkinson, C., 106, 107, 109.—Cochrane, C., 110.—Fenton, J., 108.—Forsyth, T., 109.—Maudslay, H., 109.—McConnell, J. E., 107, 109.—Ramsbottom, J., 111.—Siemens, C. W., 107, 108, 109, 110, 111.—Whitworth, J., 108, 111.

REGENERATIVE GAS FURNACE, *Paper* on a regenerative gas furnace, as applied to glass houses, puddling, heating, &c., by C. W. Siemens, 1862, 21.—Great heat obtained with very inferior fuel, 21.—Principle of regenerator, 21.—Early forms of regenerative furnace, 22.—Gas producer, 26.—Action of water in producer, 27.—Onward pressure to furnace caused by cooling of gas in tube, 28.—Plate-glass melting furnace, 29.—Arrangement of air and gas flues, 30.—Circular flint-glass furnace, 31.—Nature of gas from producer, 31.—Puddling furnace, 32.—Steel-melting furnace, 34.—Further applications, 34.

*Discussion*.—Blackwell, S. H., 42, 43.—Brown, B. L., 42.—Chance, J. T., 36, 44.—Cowper, E. A., 44.—Fenton, J., 38, 40, 42, 44, 45.—Haden, W., 40.—Lloyd, G., 38.—Mathews, W., 41, 42.—Plum, T. W., 41.—Siemens, C. W., 35, 40, 41, 42, 43, 44.—Thomson, G., 43.

REGENERATIVE HOT-BLAST STOVES. *See* Hot-Blast Stoves, 1860, 54.—1870, 62, 94.

REID, J., Jun., Preservation of Timber, *Paper* on Boucherie's process for the preservation of timber, 1856, 196.—Durability of railway sleepers, 200.—Cost of sleepers, 201.

RENNIE, G., elected Member, 1857, 202.

RENNIE, G. B., elected Member, 1859, 54.

REPORT OF COUNCIL, Annual. *See* Council, Report of.

RETORTS, GAS. *See* Gas Retorts, 1852, 178.

REVERSING ROLLING MILL. *See* Rolling Mill, Reversing, 1866, 115.

REYNOLDS, E., elected Member, 1862, 47.

Allen Engine, calculation of effect of inertia of reciprocating parts, 1868, 69.—Inefficiency of counterbalance weight on locomotive wheels, 70.—Duplex locomotive, 70.—Very successful working of Allen engine, 71.—Efficiency of Porter governor, 72.—Expansion of steam in Allen engine, 73.

Blast Furnaces, charging with movable bucket, 1864, 174.

Ships, Iron, mode of building up large welded girders, 1863, 145.

REYNOLDS, F. C., elected Member, 1866, 18.—Decease, 1869, 2.—Memoir, 17.

RHODES, J., elected Member, 1851, Jan., 8.

RICHARDS, E., elected Member, 1863, 113.

RICHARDS, E. W., elected Member, 1866, 265.

RICHARDS, JOB, elected Member, 1865, 54.

RICHARDS, JOSIAH, elected Member, 1856, 250.

RICHARDS, T. (Birmingham), Telescope, Equatorial, *Paper* on an equatorial motion for telescopes, 1855, 137.

RICHARDS, T. (Worcester), Original Member, 1847.

India-rubber Pipe Joints, used successfully for gas mains at Worcester, 1848, Oct., 22.—Less cost and better for repairs than old joints, 22.—Joints resist frost and action of gaseous matter, 23.

RICHARDSON, E., Hon., elected Member, 1863, 15.

RICHARDSON, J. (Gloucester), elected Member, 1865, 54.

RICHARDSON, J. (Lincoln), elected Member, 1873, 46.

Engines, Portable, for Mining, *Paper* on the application of portable engines for mining purposes, 1873, 167.—Consumption of coal in portable engines, 175.—Greater evaporative efficiency of multitubular boilers than Cornish, 175.—Firing of multitubular boilers, 176.—Saving of coal in portable engines, 177.—Loss in Cornish engines from inertia of moving parts, 192.—Doubtful whether condensing engines are best, 193.—Duty of portable and of Cornish engines, 193.

RICHARDSON, R., elected Member, 1862, 314.

RICHARDSON, T., elected Member, 1858, 266.

RICHARDSON, W., elected Member, 1859, 248.

Boiler Construction, firebrick arch to protect plates in cylindrical boilers, 1859, 227.—Adamson's flanged seam for internal flues very good, 227.

Boiler Explosions, failure of bottom plates from sudden cooling by feed-water, 1866, 171.—Purifying foul water for boilers at Oldham, 1870, 214.—Long feed-pipe inside boiler to prevent fracture of plates from contact with cold water, 216.

Brick Machinery, wear of moulds much reduced in dry-clay brick-making machine, 1859, 49.—Mould consists of movable case-hardened wrought-iron plates, 49.—Clay used is not absolutely dry, 50.

Iron Works, long boilers made with punched holes liable to crack, 1863, 237.—Plates burnt with very thin deposit, 239.

Magnetic Water Gauge, description of a magnetic gauge with radial index, 1860, 86.

RICHMOND, J., Engine Counter, *Paper* on an improved engine counter, 1849, Jan., 14.—Counter working successfully at Chelsea Water Works, 15.—Tried at very great speed, 16.

RICKABY, A. A., elected Member, 1873, 88.

RIDEAL, S., elected Member, 1865, 20.

RIFLES, BREECH-LOADING, *Paper* on the principal constructions of breech-loading mechanism for small arms, and their relative mechanical advantages, by W. P. Marshall, 1871, 92.—Objects to be effected in breech-loading mechanism, 92.—Prussian needle-gun first breech-loader regularly used, 92.—Breech-loading rifles not more wasteful of ammunition than muzzle-loaders, 93.—Action of Prussian needle-gun, 94.—Spitting of gas from joint of breech-block, 95.—Chassepot rifle, 96.—Berdan gun, 97.—Breech-loading sporting gun, 97.—Snider breech-action, 98.—Albini-Braendlin, 99.—Remington, 100.—Werndl, 101.—Sharps, 102.—Henry, 102.—Soper, 103.—Martini-Henry, 104.—Henry barrel, 105.—Martini breech-action, 105.—Peabody, 105.—Advantages of falling hinged block,

## RIFLES, BREECH-LOADING (continued).

106.—Defects of Martini lock action, 107.—Heavy pressure of spiral spring, 107.—Double catch to ease pull-off, 108.—Westley Richards breech-action, 109.—Pressure of spring, 110.—Advantages over Martini action, 111.

*Discussion.*—Bird, R., 114.—Greenwood, T., 115.—Ramsbottom, J., 115.—Soper, W., 113, 115.

*Adjourned Discussion.*—Henry, A., 293.—Ramsbottom, J., 294, 295.—Soper, W., 293, 294.

RIFLED GUN MANUFACTURE, *Paper* on the application of the copying principle in the manufacture and rifling of guns, by J. Anderson, 1862, 125.—Difficulty in producing accurate forms in lathe, 125.—Accuracy really cheaper in the end, 126.—Building up Armstrong guns, 128.—Use of vernier for measuring, 129.—Almost impossible to bore tubes correctly, 129.—Turning tube to fit inside bore of outer tube, 130.—Boring of finished gun, 132.—Rifling, 135.—Rifling machine, 137.—Drilling holes for sights &c., 140.

*Discussion.*—Anderson, J., 141, 142, 143, 144.—Armstrong, Sir W. G., 143, 145.—Bovill, G. H., 144.—Cowper, E. A., 142, 145.—Fletcher, J., 143.—Richardson, W., 145.

RIGBY, P., Polished Sheet Glass, first side of sheet requires longer polishing than second side, 1863, 277.

RIGBY, S., elected Member, 1863, 246.

RIGG, A., elected Honorary Member, 1863, 247.

RIGG, J., elected Member, 1871, 65.

RILEY, E., Puddling, Mechanical, tap-cinder lining for puddling vessels, 1867, 164.—Mechanical rabble not successful, 171.

Strength of Steel, a small quantity of carbon is essential in all wrought-iron, 1861, 169.—Fused wrought-iron is "red-short," 169.

Tubbing, Cast-Iron, protection of pipes by coating of carbon, 1861, 207.

RIVETED JOINTS, *Paper* on the strength and proportions of riveted joints, with the results of some recent experiments, by W. R. Browne, 1872, 53.—Single-riveted lap-joints, 55.—Proportioning of rivets, and experiments on resistance to different strains, 55.—Double-riveted lap-joints, 62.—Punched and drilled holes, 64.—Single-riveted butt-joints, 64.—Double-riveted butt-joints, 67.—Conclusions from above investigations, 68.—Diagonal-jointed boiler, 70.—Thickened-edge plates, 71.—Table of experiments, 72.

*Discussion.*—Browne, W. R., 91, 95.—Cochrane, J., 79, 81.—Fletcher, H. A., 91.—Kirtley, W., 83.—Marten, E. B., 89.—Olrick, L., 84, 95.—Perks, J. H., 83.—Robinson, J., 78, 81, 82.—Siemens, C. W., 83, 96.—Wright, J. G., 77, 78, 84, 90.

RIVETED JOINTS, Tables of Experiments, 1872, 72, 73, 78, 80.

RIVETER, HYDRAULIC. *See* Hydraulic Machinery, 1872, 196.

RIVETER, PORTABLE HYDRAULIC. *See* Hydraulic Machinery, 1872, 199.

RIVETER, PORTABLE STEAM, *Paper* on a portable steam riveter, by A. Wyllie, 1865, 129.—Great length of ordinary steam hammer, 129.—Construction of riveter, 130.—Proportioning size of cylinder &c., 131.—Slide-valve, 132.—Locking form of machine, 134.—Spring dolly, 135.—Coupled riveter, 137.

*Discussion.*—Cochrane, C., 139.—Ferne, J., 140.—Gray, J. McF., 137, 138, 139, 141, 143, 144, 145.—Murphy, J., 139, 143, 144.—Napier, R., 138, 139, 143, 145.—Naylor, W., 140.—Ramsbottom, J., 139.—Whitley, J., 144.—Wyllie, A., 137.

RIVETER, STEAM, *Paper* on an improved steam riveting, punching, and shearing machine, by R. Harvey, 1856, 134.—Description of machine, 134.—Steam valve, 135.—Punching, 135.—Mode of suspending boiler work, 136.

*Discussion.*—Fairbairn, W., 137, 138.—Fothergill, B., 138.—Harvey, R., 136, 137, 138.—Ramsbottom, J., 138.—Whitworth, J., 136, 139.

RIVET-MAKING MACHINE, *Paper* on a rivet-making machine, by C. De Bergue, 1861, 212.—Description of machine, 212.—Crushing piece, 213.—Action of header to suit continuous motion of die, 213.—Shears for cutting blanks, 214.—Speed of working, 214.—Heating furnace, 215.

*Discussion.*—Cowper, E. A., 217, 218.—Jones, E., 218.—Joy, D., 215, 216, 217, 218, 219.—Lloyd, Sampson, 215, 217, 218, 219.

ROAD ROLLER, STEAM, *Paper* on the steam road roller used in Paris, by E. Gellerat, 1869, 101.—Description of roller, 102.—Rollers inclined for steering, 103.—Driving chains, 104.—Rate and cost of working, 105.—Particulars of rolling, 106.—Relative cost of steam and horse rolling 108.—Work done by rollers, 108.

*Discussion.*—Aveling, T., 111, 116, 117.—Batho, W. F., 112.—Cowper, E. A., 113, 115, 117.—Heaton, R., 110, 112, 115, 117.—Manning, J., 114.—Penn, J., 110, 113, 116, 118.—Rolason, W., 115.—Smith, B., 113.

ROAD ROLLER, STEAM, *Paper* on a steam road roller, by W. F. Batho and T. Aveling, 1870, 109.—Original roller in Calcutta; saving of cost compared with bullock-rollers, 109.—Description of roller, 110.—Cost of working 15-ton roller, 112.—Work done by rollers, 112.—Improved form of roller, 113.—Advantages of rolling roads, 115.—Steam-rolling much better than horse-rolling, 116.—Spiked rollers for picking up surface of road, 116.—Process of repairing a road, 117.

*Discussion.*—Baldwin, J., 118.—Batho, W. F., 118, 122.—Paget, F. A., 119.—Ramsbottom, J., 123.—Robinson, J., 121.—Sadler, J., 123.—Walker, T., 123.—Yates, E., 121.



## ROAD ROLLER, STEAM (continued).

- Adjourned Discussion.*—Aveling, T., 170, 176, 177.—Chapman, H., 175, 176.—Hawksley, T., 175, 176, 178.—Leigh, E., 177.—Paget, F. A., 174.
- ROBERTS, J., elected Member, 1848, Apl., 24.
- ROBERTS, R., Safety Escape Pipe, objectionable to place fusible plugs in tubes, 1857, 181.
- ROBERTSON, A. J., Centrifugal Pump, *Paper* on the mathematical principles involved in the centrifugal pump, 1852, 99.
- Centrifugal Pump, *Supplementary Paper* on the mathematical principles involved in the centrifugal pump, 1852, 153.
- Centrifugal Pump, *Supplementary Paper* on the mathematical principles involved in the centrifugal pump, 1853, 165.
- Pile Driver, *Paper* on the theory of pile driving, with description of an improved steam pile-driving machine, 1857, 12.—Cost of pile driver, 24.
- ROBERTSON, G., elected Member, 1873, 46.
- ROBERTSON, H., elected Member, 1848, Apl., 24.
- ROBERTSON, J. (Ardrossan), Frictional Gearing, *Paper* on grooved-surface frictional gearing, 1856, 202.—Particulars of application, 209.—Speed of running, 210.—Slip in wheels, 211.
- ROBERTSON, J. (London), elected Associate, 1867, 19.
- ROBEY, R., elected Member, 1865, 218.
- ROBEY, R., Jun., elected Member, 1873, 250.
- ROBINSON, H., Original Member, 1847.
- Rotary Engine, successful working of Dundonald's rotary engine for seven years at Portsmouth, 1848, July, 5.
- ROBINSON, J. (Manchester), elected Member, 1859, 248.—Council, 1866, 16.—1869, 19.—Vice-President, 1870, 18.—1871, 20.—Council, 1872, 25.—Vice-President, 1873, 24.
- Condenser, Ejector, condensation probably not only in portion between nozzles, 1872, 272.—Desirable to have further experiments, 272.
- Injector, *Paper* on Giffard's injector for feeding steam boilers, 1860, 39.—Rise of temperature of water in passing through injector, 48.—No choking of jet by incrustation, 49.—Injector will not start at once when cold, 50.
- Injector, *Supplementary Paper* on Giffard's injector for feeding steam boilers, 1860, 74.—Temperature of feed-water does not rise with increased pressure of steam, 79.—No air drawn in at overflow pipe when working, 80.
- Injector, Self-adjusting, *Paper* on Sellers' self-adjusting injector, and other improvements on Giffard's injector, 1866, 266.—Delivery of water much greater than Giffard's calculation, 274.—Larger steam cone for higher pressures, 274.—Sensitiveness of self-adjusting arrangement, 276.—Successful application to marine boilers, 278.

ROBINSON, J. (continued).

Locomotives, Distribution of Weight, *Paper* on the distribution of weight on the axles of locomotives, 1864, 92.—Effect of connecting lever when running over obstacles, 117.

Riveted Joints, some Yorkshire iron as strong across as with the grain, 1872, 78.—Steel boiler plates not weakened by punching if annealed afterwards, 82.—Double-riveted butt-joint preferable to lap-joint, 82.—Desirable to have boiler made of rolled weldless cylinders, 82.

Shaping Machine, general extension of machine work, 1866, 284.—Saving of time by use of shaping machine, 284.

Steam Jet, petticoat blast-pipe to diminish back pressure on cylinders, 1872, 116.—Same arrangement applied to Giffard's injector, 116.—Steam jet for air blast of cupolas, 116.—Valuable for ventilating holds of ships, 117.

Steam Road Roller, advantage of bearing springs for heavily-weighted vehicles, 1870, 121.

ROBINSON, J. (Rochdale), elected Member, 1865, 102.

Dovetailing Machine, *Paper* on the American dovetailing machine, 1868, 81.—Adjusting tightness of fit of dovetails, 86.—Fine teeth for hard woods, 88.

ROBINSON, T., elected Member, 1851, Oct., 28.

ROBINSON, W., elected Honorary Member, 1852, 41.

ROBSON, J., elected Member, 1858, 80.

ROBSON, N., Blast Furnaces, difference in dimensions and yield between Scotch and Cleveland furnaces, 1864, 258.—Charge of furnaces working blackband ironstone, 259.—Failure of taking off waste gas in Scotland, 262.

ROBSON, T., elected Member, 1866, 265.

ROCHE, D. M., Original Member, 1847.—Decease, 1858, 2.

ROCK-BORING MACHINE. *See* Boring Machine, 1865, 179.

ROE, T., Jun., elected Associate, 1867, 60.

ROFE, H., elected Member, 1852, 191.

ROFE, H., Jun., elected Member, 1872, 76.

ROGERS, E., elected Member, 1851, July, 45.

Coking, *Paper* on the manufacture of charcoal and coke, 1857, 25.—Ovens for coking semi-anthracite coal, very expensive, 35.—Yield of coke from new kilns, 36.—Heating power of coke dependent on texture, 39.—Cost of coking in ovens and kilns, 39.

Compressed-Air Engine, cooling effect of exhaust air, 1856, 148.

Ventilating Fan, Nasmyth, *Paper* on the ventilating fan at the Abercarn collieries, 1856, 251.—Principles of various mechanical ventilators, 260.—Saving of fuel, 261.—Failure of steam-jet ventilators, 262.—Degree of vacuum, 262.—Horizontal fan not successful, 263.—Importance of increasing current of ventilation on occasion of explosion, 264.

ROGERS, J., elected Member, 1853, 45.

ROGERS, W., elected Member, 1868, 43.

ROLINSON, J., Safety Boiler Apparatus, *Paper* on an improved apparatus for preventing explosions of steam boilers, 1853, 134.

ROLLERS FOR DRAWING COTTON, construction of. *See* Cotton-Drawing Rollers, 1863, 59.

ROLLERS, STEAM, FOR ROADS. *See* Road Roller, 1869, 101.—1870, 109.

ROLLING-MILL ENGINES. *See* Dowlais Ironworks Engines, 1857, 112.

ROLLING MILL, REVERSING, *Paper* on an improved reversing rolling mill, by J. Ramsbottom, 1866, 115.—Description of rolling mill and engines, 115.—Clutch, 116.—Rapidity of reversing, 117.—Rolls, 117.—Tightening-down gear, 118.—Levers for entering slabs into rolls, 120.

*Discussion.*—Bellhouse, E. T., 124.—Bramwell, F. J., 123.—Fairbairn, W., 121, 126.—Ferne, J., 125.—Fothergill, B., 122.—Lloyd, Sampson, 122.—Maudslay, H., 122, 127.—Napier, R., 121, 123.—Perry, W., 126.—Ramsbottom, J., 120, 121, 122, 123, 125, 126, 127.—Sparrow, W. M., 125.—Whitworth, J., 120, 128.—Yule, W., 127.

ROLLO, D., elected Member, 1871, 117.

Surface Condensers, very difficult to account for corrosive action of distilled water, 1863, 158.—Steel tubes corrode quite as quickly as iron tubes, 162.—Surface condensers do not cause priming, 162.—Position of feed-pipe does not affect corrosion, 165.

RONAYNE, J. P., elected Member, 1853, 8.

RONEY, C. P., elected Honorary Member, 1848, Apl., 24.

ROOF, BIRMINGHAM STATION, *Paper* on the wrought-iron roof over the central railway station at Birmingham, by E. A. Cowper, 1854, 79.—Special circumstances of site, 80.—Description of roof, 80.—Principals, 80.—Supports for principals, 81.—Purlins, 81.—Glazing, 82.

*Discussion.*—Cowper, E. A., 82, 83, 85, 86, 87.—Fairbairn, W., 83, 85, 86, 87.—McConnell, J. E., 84, 86, 87.

ROOT'S BOILER. *See* Boiler, 1871, 229.

ROPE MANUFACTURE, *Paper* on the manufacture of hemp and wire ropes, by C. P. B. Shelley, 1862, 170.—Different substances used for making hemp ropes, 170.—Preparation of hemp fibres, 171.—General construction of ropes, 172.—Three classes of ropes, 173.—Heckling, 174.—Hand spinning, 175.—Sizes of yarn, 178.—Winding, 178.—Forming, 179.—Laying, 180.—Cartwright's "cordelier," 182.—Huddart's spinning machine, 183.—Tarring, 184.—Registering machine, 185.—Laying machine, 186.—Comparative strength of ropes, 187.—Wire-rope, 188.—Selvagee, 188.—Formed rope, 190.—Flat wire-ropes, 192.—Laid rope, 193.—Machines for making laid wire-ropes, 194.—Smith's wire-rope machine, 197.

## ROPE MANUFACTURE (continued).

*Discussion.*—Bramwell, F. J., 202.—Cowper, E. A., 204, 205, 208.—Fletcher, J., 203, 206.—Fothergill, B., 201, 202, 204.—Haggie, P., 203, 205, 206, 207, 208.—Hawksley, T., 203, 205, 207, 208, 209.—Jenkin, F., 205.—Shelley, C. P. B., 200, 202, 207.—Smith, A., 201, 206, 207.—Snowdon, T., 206.

ROSE, H. F., elected Member, 1867, 18.

ROSE, T. (Bilston), elected Member, 1867, 18.

ROSE, T. (Manchester), elected Member, 1866, 18.

ROSE, W. N., elected Member, 1869, 276.

ROSS, J., elected Member, 1853, 8.—Decease, 1862, 3.—Memoir, 17.

Decimal Measure, foot should be abandoned, and dimensions given only in inches, 1857, 229.

Spring, convex-plate springs very light, and suitable for railway springs, 1857, 226.

Tuyere, *Paper* on an improved tuyere for smiths' hearths, 1855, 30.

ROSS, R. C., File-Cutting Machine, *Paper* on a new machine for cutting and forging files, 1856, 226.

ROSTHORN, J. D., elected Member, 1866, 18.

ROTARY ENGINE, *Paper* on the fallacies of the rotary engine, by G. Stephenson, 1848, July, 3.—Increased leverage given by crank in middle of stroke and diminished leverage at ends, 3.—Gain of power equal to loss, and no power lost by crank motion, 3.—Weight at piston balances same weight on a drum at crank with circumference equal to piston stroke, 3.—Rotary engine can only give out same power through equal space, 4.

*Discussion.*—Gibbons, B., 6.—Miller, J., 4, 5.—Onion, 4.—Robinson, H., 5.—Slate, A., 4.—Stephenson, G., 4, 5, 6.

ROTARY WATER METER. *See* Water Meter.

ROUGHTON, L., elected Graduate, 1850, Apl., 30.

ROUND-OAK IRONWORKS. *See* Ironworks, Round-Oak, 1860, 211.

ROUSE, F., elected Member, 1856, 79.

ROUTLEDGE, W., elected Member, 1857, 202.

Safety Escape Pipe, composition of fusible plugs, 1857, 181.

ROWAN, J. M., elected Member, 1848, Apl., 24.

RULES OF INSTITUTION, Alteration, 1853, 7.—1855, 5.—Title of Past-President, 1863, 14.—Age for admission of Graduates and Members, 1866, 5.—Title of Associate, 5.—Communications to be the property of the Institution, 5.—Times and places of Meetings, 5.—Subscriptions, arrears, property of Institution, 1869, 6.

Spring Meetings to be held in London, 1873, 25.—Circular for opinions of Members, 30.—Notice for alterations of rules, 30.

## RULES OF INSTITUTION (continued).

*Discussion.*—Adamson, D., 28.—Alliott, J. B., 27.—Bagshawe, J. J., 28.—Carbutt, E. H., 27.—Cowper, E. A., 26, 28.—Field, E., 25.—Head, J., 26, 27.—Hulse, W. W., 26, 27.—Kershaw, J., 27.—May, W., 28.—Olrick, L., 29.—Paget, A., 25, 26, 27, 28.—Plum, T. W., 29.—Ramsbottom, J., 29.—Siemens, C. W., 26, 27, 29.—Walker, C. C., 28.—Williams, R., 25.

RUMBLE, T. W., elected Member, 1860, 90.

RUSSEL, R., elected Member, 1856, 7.—Decease, 1861, 2.

RUSSELL, J. J., elected Member, 1849, Jan., 9.

High-Pressure Steam Boiler, *Paper* on Benson's high-pressure steam boiler, 1861, 30.—No injury done if tubes burst, 39.—Amount of superheating, 40.

RUSSELL, J. SCOTT, elected Member, 1847.—Council, 1849, Jan., 9.—1850, Jan., 5.—1853, 8.—Vice-President, 1855, 5.—1856, 6.

Copper Sheathing, great variations in durability, 1862, 231.

Decimal Measure, Inch and Metre, present inconvenience not the only consideration, 1865, 46.—Metre probably best standard, 46.—Inconvenience from having no relation between measures of length and weight, 47.

Double-Cylinder Engines, difficulties in carrying out expansion in marine engines, 1862, 275.—Three-cylinder expansive marine engine, 275.

Iron Armour for Ships, defects of wood backing, 1862, 307.—Armour must be a single thickness of metal, 307.—Very desirable to adopt iron backing, 308.

Stephenson, George, notice of the life and character of the late George Stephenson, first President of the Institution, 1848, Oct., 3.

RUSSELL, N. S., Iron Armour for Ships, *Paper* on the construction and application of iron armour for ships of war, 1862, 289.—Continuous riveting most secure method of fastening plates, 309.

RUSTON, J., elected Member, 1867, 60.

RYDER, J. N., elected Member, 1859, 14.

Superheated Steam, *Paper* on the application of superheated steam, 1860, 22.

RYDER, W., elected Member, 1863, 58.—Decease, 1868, 2.—Mémorial, 17.

RYLAND, F., elected Graduate, 1866, 265.

## S.

SACRE, A. L., elected Member, 1866, 103.

SACRE, C., elected Member, 1859, 248.

SACRE, E. A., elected Member, 1868, 103.

SADOINE, E., elected Member, 1867, 234.



**SAFETY BOILER APPARATUS**, *Paper* on an improved apparatus for preventing explosions of steam boilers, by J. Rolinson, 1853, 134.—Description of apparatus, 134.—Results of working, 135.

*Discussion.*—Beyer, C. F., 136.—Downing, G., 135.—Gibbons, B., 135, 136.—Ramsbottom, J., 136.—Rolinson, J., 135, 136.

**SAFETY BUFFER.** *See* Buffer, Safety, 1848, Apl., 15.

**SAFETY ESCAPE PIPE**, *Paper* on a safety escape pipe for steam boilers, by J. Ramsbottom, 1857, 179.—Description of safety pipe, 179.—Experiments on efficiency, 180.

*Discussion.*—Craig, W. G., 138.—Dodds, I., 182.—Ramsbottom, J., 180, 183.—Rankine, W. J. M., 182.—Roberts, R., 181.—Routledge, W., 181.—Siemens, C. W., 182.—Smith, W., 181, 182.—Tomlinson, J., 183.—Whitworth, J., 180, 183.

**SAFETY HOIST GOVERNOR.** *See* Hoist Governor, 1858, 269.

**SAFETY LAMP**, *Paper* on an improved miner's safety lamp, by S. H. Blackwell, 1851, Oct., 23.—Defects of ordinary Davy lamp, 24.—Description of Eloin lamp, 24.—Advantages, 25.

*Discussion.*—Blackwell, S. H., 27, 28.—Clift, J. E., 27, 28.—Slate, A., 27.

**SAFETY MINE APPARATUS**, *Paper* on a safety apparatus for working mine shafts, by A. Slate, 1854, 57.—Description of apparatus, 58.—Mode of action, 58.—Cost, 59.

*Discussion.*—England, W., 59, 60, 61.—Mathews, W., 61.—Slate, A., 60, 62.—Thomson, G., 60, 61, 62.—Williams, R., 60.

**SAFETY VALVE, FENTON**, *Paper* on an improved safety valve, for locomotive, marine, and stationary steam boilers, by J. Fenton, 1855, 24.—Description of single valve, 25.—Double valve, 26.—Lock-up nature of valves, 27.

*Discussion.*—Adams, W. A., 29.—Fairbairn, W., 27, 28, 29.—Fenton, J., 27, 28, 29.—Fothergill, B., 28, 29.—May, W., 28.

**SAFETY VALVE, HASTE**, *Paper* on Haste's improved safety valve for steam boilers, by W. Naylor, 1859, 186.—Explosions caused by safety valves not taking off steam as fast as generated, 186.—Description of Haste's valve, 188.—Effective force for opening escape valve, 188.—Experiments on efficiency of valve, 189.—Pressure rises while blowing off with ordinary safety valve, 190.—Explosions from low water prevented by Haste's valve, 191.

*Discussion.*—Fothergill, B., 192.—Maudslay, H., 193.—Naylor, W., 192, 193.—Penn, J., 192, 193.

**SAFETY VALVE, HUGHES**, *Paper* on a self-acting safety and fire-extinguishing valve for steam boilers, by G. D. Hughes, 1870, 219.—Desirability of low-water valve or indicator, 219.—Principle of action, 220.—Description, 221.—Special advantages, 222.—Fusible plugs often fail, 223.

## SAFETY VALVE, HUGHES (continued).

*Discussion.*—Chapman, H., 225.—Fletcher, L. E., 225.—Hawksley, T., 223, 224, 225.—Hughes, G. D., 223, 224, 225.

SAFETY VALVE, KAY, *Paper* on an improved construction of safety valves for steam boilers, by J. C. Kay, 1857, 211.—Description of three constructions of improved safety valves, 211.—Action of valve, 212.—Auxiliary relief valve, 214.

*Discussion.*—Fairbairn, W., 216, 218.—Fothergill, B., 217.—Inshaw, J., 217.—Kay, J. C., 215, 216, 217.—McConnell, J. E., 215, 216.

SAFETY VALVE, NAYLOR, *Paper* on an improved safety valve for steam engine boilers, by W. Naylor, 1865, 220.—Defects of ordinary valve, 220.—Increase of pressure caused by opening valve, 221.—Description of improved valve, 222.—Ordinary large valves allow greater increase of pressure while blowing off than small valves, 224.—Causes of extra pressure in locomotives, 225.—Comparison of ordinary and improved valves, 227.

*Discussion.*—Bramwell, F. J., 229, 230.—Cannell, F. J., 231.—Maudslay, H., 228, 231, 234.—Naylor, W., 227, 228, 230, 231, 232, 233, 234.—Smith, W. F., 231.—Tomlinson, J., 232.—Webb, F. W., 233.

SAFETY VALVE, RAMSBOTTOM, *Paper* on an improved safety valve, by J. Ramsbottom, 1856, 37.—Description of double safety-valve, 38.—Spring, 39.

*Discussion.*—Fairbairn, W., 39, 40.—Fenton, J., 40.—Ramsbottom, J., 39, 40.—Wright, H., 40.

SAFETY WAGON COUPLING. *See* Railway Safety Wagon Coupling, 1860, 277.

SAID, M., Col., elected Member, 1864, 59.

SALMON, F. B., elected Member, 1872, 76.

SALT, G., elected Member, 1859, 54.

SALT, S., elected Honorary Member, 1847.

SAMUDA, J. D'A., elected Member, 1864, 271.

SAMUEL, J., elected Member, 1848.

Expansion Engine, *Paper* on a continuous expansion steam engine, 1852, 27.—*Supplementary Paper*, 41.—Trials of expansion locomotives, 48, 49.—Continuous expansive action, 51.

Locomotive, *Paper* on an express locomotive engine, 1848, June, 8.—Great saving in wear of rails from light weight of engine, 10.

Railway Economy, *Paper* on the economy of railway transit, 1849, Oct., 4.—Small engine allows larger bearings in proportion and higher boiler pressure, 11.—Large carriage gives great saving of weight per passenger, 11.

SAMUELSON, A., elected Member, 1857, 55.

Oil Mill Machinery, *Paper* on oil mill machinery, 1858, 27.—Recoil of press desirable after each stroke, 38.—Durability of crushing rollers, 39.—Horizontal presses no advantage over vertical, 40.—Safety valves of oil presses, 42.

SAMUELSON, B., elected Member, 1865, 20.

SAMUELSON, M., elected Member, 1857, 55.

SANDBERG, C. P., elected Member, 1865, 218.

Blast-Furnace Gas, Swedish plan of taking off waste gas, 1865, 252.

SAND BLAST, *Paper* on Tilghman's sand-blast process, and its application for cutting stone, &c., by W. E. Newton, 1873, 260.—Sand and pebbles assist in cutting hard rocks in hydraulic mining, 261.—Soft and elastic substances less affected by sand blast than hard and brittle ones, 261.—Description of apparatus, 262.—Bent blast-pipe with short nozzle for cutting narrow deep grooves, 264.—Dressing of stone balusters, &c., 264.—Cutting of nozzle tube by the sand, 265.—Quarrying and tunnelling, 266.—Grinding and ornamenting glass, &c., 267.—India-rubber stencils successful, 268.—Engraving gelatine photographs on glass, 269.—Other applications, 269.

*Discussion.*—Aitken, W. C., 275, 276.—Amos, C. E., 274, 275.—Halpin, D., 277.—Lloyd, Z., 272, 273.—Maltby, W., 277.—Newton, W. E., 270, 271, 272, 273, 274, 275, 276, 277.—Paget, A., 273, 274.—Siemens, C. W., 271, 277.—Walker, C. C., 277.

SANDERS, J., elected Honorary Member, 1847.

SANDERS, R. D., elected Member, 1871, 262.

SANDERSON, G. G., elected Member, 1861, 14.

SANDERSON, G. S., elected Member, 1848.

SANDERSON, J., elected Member, 1864, 59.

SANDFORD, C., elected Member, 1848, Apl., 24.

SCARLETT, J., elected Member, 1869, 276.

SCHAEFFER PRESSURE GAUGE. *See* Pressure Gauges, 1871, 281.

SCHANSCHIEFF, A., elected Member, 1869, 77.

SCHMITTHENNER, L. S., elected Member, 1856, 80.

SCHNEIDER, H. W., elected Member, 1860, 90.

SCHOLTZE, A., elected Member, 1866, 55.

SCOTT, E., elected Member, 1865, 218.—Decease, 1873, 2.—Memoir, 21.

SCOTT, G. L., elected Member, 1868, 103.

Wheel Moulding, *Paper* on the moulding of toothed wheels, and an improved wheel-moulding machine, 1868, 238.—Cost of machines, 246.—Economy from use of machine, 249.—No skill required to use machine, 250.

SCOTT, J., elected Member, 1858, 80.

SCOTT, J. P., elected Associate, 1866, 18.

SCOTT, M., elected Member, 1848, July, 20.

Dredging Ladder, *Paper* on an improved ladder for dredging machines, 1856, 217.

Pile Driver, *Paper* on the theory of pile driving, with description of an improved steam pile-driving machine, 1857, 12.

SCOTT, W. H., elected Member, 1861, 211.

SCRAPER, *Paper* on the mechanical scraper for removing incrustation in the mains of the Torquay Water Works, by J. Little, 1873, 216.—Reduction of delivery due to oxidation of pipes by unusually soft water, 216.—First form of scraper, 217.—Success of trial scraping, 218.—Cup for removing stones in main, 218.—Application of two separate pistons, 219.—Scraping knives, 219.—Improved arrangement of knives, 220.—Following the motion of scraper by the sound, 221.—Force required to drive scraper, 221.—Increased delivery obtained by scraping, 222.—Application of scraper to smaller mains, 222.

*Discussion.*—Bramwell, F. J., 230, 231.—Easton, E., 230, 231.—Froude, W., 223, 229.—Head, J., 230.—Hughes, G. D., 229.—Husband, W., 229.—Weeks, T. S., 223, 230.

SCREW PROPELLER, *Paper* on a new improved screw propeller, by G. H. Bovill, 1852, 163.—Ordinary form of screw propeller, 164.—Description of Griffiths' propeller, 165.—Loss of power from flapping action of centre part of ordinary propellers, 165.—Improved form of blades, 166.—Pitch of screw, 168.—Slip, 169.—Table of trials of old and new forms of propeller, 170.

*Discussion.*—Appold, J. G., 172, 173.—Gibbons, B., 173.—Preston, R. B., 172.—Ramsbottom, J., 172.—Whitworth, J., 173.

SCREWING MACHINE, *Paper* on Sellers' screwing machine, by C. P. Stewart, 1861, 231.—Description of machine, 231.—Releasing bolt after screwing, 232.—Adjustment of cutting dies, 232.—Adjustment of machine for tapping nuts, 233.—Cutting the dies, 234.—No adjustment necessary while working, 234.

*Discussion.*—Cowper, E. A., 237.—Cunliffe, R., 235, 236, 237.—Joy, D., 236.—Lloyd, Sampson, 235, 238.—Murphy, J., 236, 237.—Tomlinson, J., 237.

SCRIVEN, C., elected Member, 1868, 104.

SEDDON, J., elected Member, 1864, 59.

SEDDON, J. F., elected Member, 1873, 46.

SELBY, G., elected Member, 1847.

SELBY, G. T., elected Member, 1857, 55.

SELBY, M., elected Member, 1867, 18.

SELLERS, W., elected Member, 1865, 218.

SELLERS' Self-Adjusting Injector. *See* Injector, 1866, 266.

SHAFTS AND AXLES. *See* Axles.

SHANKS, ANDREW, elected Member, 1850, Jan., 5.—Decease, 1870, 2.—Memoir, 16.

SHANKS, ARTHUR, elected Member, 1872, 119.

SHAPING MACHINE FOR NUTS, *Paper* on an improved machine for shaping nuts, &c., by W. F. Batho, 1869, 312.—Description of machine, 312.—Cutters, 313.—Traversing motion, 313.—Adjustment of cutters, 314.

*Discussion.*—Batho, W. F., 315, 316, 318.—Cowper, E. A., 318.—Mather, W., 316.—Ramsbottom, J., 315, 317, 318.—Smith, F. F., 316, 317.

SHAPING MACHINE FOR WHEELS, *Paper* on a curvilinear shaping machine, by F. W. Webb, 1866, 280.—Description of machine, 280.—Rounding corners of spokes and rim, 281.—Saving in smith's work, 282.—Importance of balancing wheels correctly, 282.

*Discussion.*—Bramwell, F. J., 285.—Cowper, E. A., 286.—Lloyd, Sampson, 283, 287.—Robinson, J., 284, 287.—Webb, F. W., 283, 285, 286.

SHAPING MACHINE FOR WOOD, *Paper* on improved machinery for rounding, surfacing, and shaping wood, by J. W. Wilson, 1857, 77.—Rounding machine for poles, &c., 77.—Cooling the die, 77.—Cylindrical gouge and disc paring-tool, 78.—Heading machine for rounding ends of sticks, 78.—Octagoning machine, 79.—Conical rounding machine for paint-brush handles, &c., 80.

*Discussion.*—Hoskyns, C. W., 81.—Smith, W., 82.—Waller, W., 81.—Whitworth, J., 81, 82.—Wilson, J. W., 81, 82.—Wright, H., 81.

SHARP, H. (Bolton), elected Member, 1863, 246.

SHARP, H. (Manchester), elected Member, 1848, Apl., 24.

SHARP, J., elected Member, 1847.

SHARP, W. P., elected Member, 1848, Apl., 24.

SHARPE, C. J., elected Member, 1867, 60.

SHARPE, W. J., elected Member, 1862, 20.

SHARROCK, S., elected Member, 1869, 77.

SHAW, D., elected Member, 1864, 121.

SHAW, F., elected Member, 1866, 18.—Decease, 1868, 2.—Memoir, 18.

SHEARS, HYDRAULIC. *See* Hydraulic Shears and Punch, 1862, 341.—Hydraulic Shearing Press, 1858, 70.

SHED FOR LOCOMOTIVE ENGINES. *See* Engine Shed, 1851, Jan., 22.—1858, 256.

SHEFFIELD Summer Meeting, 1861, 109.

SHELLEY, C. P. B., elected Member, 1856, 7.

Rope Manufacture, *Paper* on the manufacture of hemp and wire rope, 1862, 170.

SHEPHERD, J., elected Member, 1861, 211.



SHERIFF, J. D., Railway Chair, *Paper* on the bracket chairs for suspending double-headed rails on the West Cornwall Railway, 1873, 252.

SHERRIFF, A. C., elected Honorary Member, 1859, 248.

SHIPS, ARMOUR-PLATED. *See* Armour for Ships, 1862, 289.

SHIPS, IRON, *Paper* on a new construction of iron ships for war purposes, by P. Conti, 1856, 221.—Wooden ships destroyed by insects in Sardinia, 221.—Effect of shot on iron plates, 221.—Description of improved iron framing, 222.—Repairing shot-holes, 233.

*Discussion.*—Conti, P., 224, 225.—Fairbairn, W., 224.—Fothergill, B., 224.—Napier, J. R., 224.—Whitworth, J., 225.

SHIPS, IRON, *Paper* on the construction of iron ships, by J. Vernon, 1863, 115.—Increase in number of iron vessels, 115.—Superiority of iron over wood, 116.—Strength of iron ship when supported at both ends only, 118.—Strength of iron ship supported at centre, 122.—Wood ship supported at both ends, 123.—Wood ship supported at centre, 125.—Iron keels and keelsons, 127.—Iron stringers, 128.—Large forgings for stern posts, &c., 129.—Screw colliers with water ballast, 130.—Flat-bottomed river boats, 130.—Bourne's floating trains, 131.—Area of canvas, 132.—Use of steel instead of iron, 132.—Riveting, &c., 133.—Objections to iron ships, 135.—Wire-rope rigging, 136.—Comparative strength of steel and wood yards, 137.

*Discussion.*—Arnott, T. R., 141.—Bennett, P. D., 139.—Birckel, J. J., 143.—Clay, W., 139, 144, 147, 149.—Gray, J. McF., 144.—Harman, H. W., 142.—Plum, T. W., 145.—Reynolds, E., 145.—Richardson, W., 143.—Scott, M., 146.—Vernon, J., 140, 141, 142, 143, 144, 146, 147, 148.

SHIPS, MODELS, *Paper* on a machine for shaping the models used in experiments on forms of ships, by W. Froude, 1873, 202.—Ordinary wood models not suitable for extensive series of experiments, 202.—Wood not suitable as material; hard paraffin successful, 203.—Rough-casting the models, 204.—Description of shaping machine, 204.—Action of template in guiding cutters, 206.—Driving of cutters, 207.—Construction of templates, 208.—Delicate adjustment of tracer for following template, 209.—Mode of cutting water-lines on model, 210.—Final dressing by hand, 210.—Use of templates in designing, 211.

*Discussion.*—Bramwell, F. J., 215.—Easton, E., 213.—Froude, W., 212, 214.—Head, J., 214.—Tilghman, B. C., 214.

SHIPTON, J. A., elected Member, 1849, July, 39.

Pendulous Engine, *Paper* on the direct conversion of rectilinear into circular motion in the steam engine, 1851, Oct., 4.—Cost of engine, 8.—Cylinder vibrates as pendulum at working speed, 9.

Steam Engine, *Paper* on a new reciprocating steam engine, 1850, July, 26.—Rate of working, 34.

SHIRLEY, H. L., elected Member, 1872, 119.

SHOOLBRED, J. N., elected Member, 1872, 119.

SHUTTLEWORTH, J., elected Member, 1859, 248.

SIEMENS, C. W., elected Member, 1851, July, 45.—Council, 1857, 11.—1860, 13.—1864, 18.—1867, 17.—Vice-President, 1868, 19.—1869, 19.—1870, 18.—1871, 20.—President, 1872, 25.—1873, 24.

Address as President, 1872, 27, 120.—Meeting in London, 120.—House of Institution, 120.—Annual consumption of coal in England, 122.—Consumption of marine engines reduced one half in last nine years, 123.—Corn grinding, 124.

Aero-Steam Engine, causes of advantage of air-injection in assisting evaporation and preventing priming in boiler, 1870, 245.—Explanation of economy from mixed steam and air in cylinder, 247.

Air Engine, Heated, steam better than air, 1873, 82.—Pipe-joint to resist high temperature, 82.—Conception of a perfect engine, 83.—Theoretical minimum consumption, 84.—Air-engine necessarily imperfect for developing power from heat, 84.—Expansion cannot be carried far in Wenham's engine, 85.—Working of air pump, loss of useful effect, 85.—Hot-air engine impracticable on large scale, though safe and useful for small power, 85.

Blast Furnaces, amendments necessary in calculation of theoretical minimum consumption, 1869, 63.—Heat carried in by blast very nearly balanced by heat carried off in escaping gas, 67.

Blast-Furnace Gas, impossible to reduce consumption to stated theoretical minimum, 1869, 33.—Temperature of gas affected by rate of driving, 39.

Blast-Furnace Materials, flued coke-ovens preferable to common ovens, 1871, 165.—Coking of anthracite, 166.—Desirable to concentrate all operations of smelting within furnace, 167.

Blooming Machine, power required to work machine and hammer, 1851, Apl., 42.

Boiler, advantage of superheating steam, 1855, 196.

Boiler, Cast-Iron, great strength of spheres in Harrison boiler, 1864, 83.

Boiler, High-Pressure, much heat wasted by passing into chimney, 1861, 40.—Tubular form of boiler very strong, 40.

Break Drums, graphite in cast-iron break-blocks acting as lubricant, 1871, 208.

Condenser, Ejector, annular water jet would probably give better result, 1872, 270.—Experiments on mode of action of condenser, 271.

Counter-pressure Steam Break, *Paper* on Le Chatelier's plan of using counter-pressure steam as a break in locomotive engines, 1870, 21.—Necessity for water injection, 37.—Small percentage of water in spray of injection, 39.—Counter-pressure system extensively used in France and Germany, 40.—Steam jet for lubrication when running without steam,

SIEMENS, C. W. (continued).

- 40.—Water jet quite sufficient, 55.—Cause of flatness of compression curve, 57.
- Crane, steel wire-rope at high speed with large pulley for transmitting power, 1868, 171.
- Cupola, iron less exposed to blast than in ordinary cupola, 1868, 94.—Krigar's cupola greatly superior, 94.
- Decimal Measure, metre more convenient than inch as standard unit, 1860, 230.—Facility of working with metric measurements, 1865, 42.—Not much importance in astronomical basis of standard, 43.—Importance of direct relation between measures of length and surface and capacity, and weights, 44.
- Disintegrator, working capacity depends on length of beaters, 1872, 49.—Very thorough mixture effected by machine, 52.
- Elevator for Colliery Drainage, very wasteful of heat, 1861, 227.—Depositing box to free steam from condensed water, 228.
- Expansion of Steam, *Paper* on the expansion of isolated steam, and the total heat of steam, 1852, 131.
- Governor, Allen, action of governor on valve indirect, 1873, 60.—Power to move valve very small, 61.—Action of Siemens liquid governor, 61.—Difference of action between Allen and Siemens governors, 62.
- Governor, Chronometric, *Paper* on an improved governor for steam engines, 1853, 75.—Advantage in increased speed of work, 83.—Experiment showing prompt action on change of load, 84.—Perfect uniformity of motion produced, 85.
- Governor, Chronometric, *Paper* on an improved chronometric governor for steam engines, &c., 1866, 19.—Tilting does not interfere with action of governor, 32.—Sensitiveness of clock-governor, 33.—Governor efficient for sudden heavy changes of work, 34.—Level of water regulates speed of revolution, 39.—Power of governor for overcoming resistance varies with density of liquid, 39.—Quantity of water affects only speed of governor, 39.—No loss of water from evaporation, &c., 40.
- Governor, Crossed-arm governor has almost chronometric action, 1871, 226.—Addition of spring increases power to move throttle-valve, 227.
- Gyroscope, description of Fessel's gyroscope, 1854, 106.
- India-rubber Covering Machine, *Paper* on a machine for covering telegraph wires with india-rubber, 1860, 137.—Objections to use of gutta-percha as insulating material, 144.
- Injector, calculation of rise of temperature in feed-water, 1860, 78.
- Marine Engines, consumption of coal in marine engines reduced to one half during last nine years, 1872, 163.—Mechanical firing should be tried for marine boilers, 171.—Compound engines enable a higher pressure of steam to be employed, 185.

## SIEMENS, C. W. (continued).

- Mining Machinery, loss of power from heavy beam of pumping engine due only to increased friction of bearings, 1859, 40.
- Pumping Engines, Cornish engine best for deep pits, 1853, 58.—Importance of steam-jackets, 58.
- Railway Chair, Bracket, rail much weakened by bolt-hole through, especially steel rail, 1873, 256.—Little difference whether holes punched or drilled, 256.—Effect of chemical composition on mode of breaking of steel, 258.
- Rankine, W. J. M., notice of decease, 1873, 22.
- Regenerative Condenser, *Paper* on a new regenerative condenser for high-pressure and low-pressure steam engines, 1851, July, 20.—Saving of fuel, 35.—Cooling of condensing water in locomotives, 36.
- Regenerative Furnace, *Paper* on a new construction of furnace, particularly applicable where intense heat is required, 1857, 103.—No decided difference in time of puddling with regenerative furnace, 110.
- Regenerative Gas Furnace, *Paper* on a regenerative gas furnace, as applied to glasshouses, puddling, heating, &c., 1862, 21.—Decomposition of crude gas in regenerators, 36.—Perfect control over nature of flame, 40.—No deposit to choke up regenerators, 41.—Temperature of furnace, 42.—Cost of regenerative puddling furnaces, 44.
- Regenerative Hot-Blast Stoves, pyrometer for measuring temperature of blast, 1860, 64.—Gas better than coal for heating regenerators, 68.
- Riveted Joints, thickened-edge plates, heaviest strain across grain of plate, objectionable, 1872, 83.—Decided advantage in diagonal-jointed boiler, 96.—Thickened-edge plates not a good plan, 96.
- Rules of the Institution, alterations, 1873, 25, 26, 27, 29, 30.
- Steam Engine, advantage of steam-jacket, 1855, 202.—Clothing saves only part of heat lost by not having steam-jacket, 203.
- Steam Jet, *Paper* on a steam jet for exhausting air &c., and the results of its application, 1872, 97.—First applied to pneumatic despatch tube, 110.—Weight of air delivered depends on surface of contact of steam and air, and not on pressure of steam, 111.—Limit of exhaustion or compression depends on pressure of steam, 111.—Time required to reduce pressure of air one lb., constant for all degrees of vacuum, 112.—Expanding delivery tube very important, 113.—Importance of very thin annular steam-jet, 114.—Most advantageous when producing high degree of vacuum, 115.
- Steering Engine, Steam, difficulty in manipulating vessel for picking up submarine cables, 1867, 280.—Reaction propeller advantageous for steering in narrow channels &c., 286.
- Superheated Steam, expansion of steam at increased temperatures, 1860, 31.—Prevention of condensation in cylinder is chief economy in superheating, 32.—Joint to stand high temperatures, 33.

SIEMENS, C. W. (continued).

Telegraph Cables, india-rubber and gutta-percha as insulators, 1862, 226.—Danger of sheathing-wires breaking, 227.—Untwisting of cable during laying, 228.—Causes of failure in cables, 229.—Conductivity of copper much diminished by very little impurity, 232.—Manufacture of copper strips for sheathing cables, 234.—Thick wires necessary for sheathing, 236.—Copper-sheathed cable will support its own weight in much greater depth of water than wire-sheathed cable, 236.

Telegraph Machinery, machinery for laying Mediterranean cables, 1867, 35.—Improved dynamometer, 36.—Hydraulic friction breaks, 37.—Turntable for light cables when in tanks, 38.—Difficulty of grappling for cables in Mediterranean Sea, 38.—Destruction of hemp covering by marine animals, 40.

Turning Tool, advantage due partly to lubrication of cutting edge, 1872, 292.

Type-Setting Machine, arrangement for preventing two keys being pressed down together, 1863, 55.

Valve Gear, Corliss gear gives correct indicator figure for all degrees of expansion, 1868, 187.—Corliss gear objectionably complicated, 187.—Friction break gives very correct result, 189.

Water Axlebox, power required to overcome friction of ordinary axleboxes, 1860, 186.—No danger from freezing of water in axlebox, 187.

Water Meter, *Paper* on an improved water meter, 1854, 6.—Accuracy of meters under trial, 20.—Cost, 21.—Objectionable to have counting gear in water, 22.

Water Meter, *Paper* on an improved water meter, 1856, 113.—Accuracy of registration, 119.

SIEMENS CHRONOMETRIC GOVERNOR. *See* Governor, Chronometric, 1853, 75.—1866, 19.

SIEMENS, F., elected Member, 1862, 20.

SIGNALS AND POINTS. *See* Railway Signals.

SIGNAL WIRES change in length from temperature, 1873, 41.

SILVESTER, J., elected Member, 1862, 93.

SILVESTER PRESSURE GAUGE. *See* Pressure Gauges, 1871, 281.

SIMMONS, J. L. A., Capt., elected Honorary Member, 1848.

SIMON, H., elected Member, 1871, 117.

SIMONS, W., Steam Dredgers, construction and working of screw hopper-barges, 1864, 157.—Increase of revenue from enlarging channel of Clyde, 158.

SIMPSON, A., elected Graduate, 1873, 251.

SIMPSON, J., Steam Engine, trial of new reciprocating steam engine, 1850, July, 32.—Steam pressure required to start engine, 34.

SIMPSON, W., elected Member, 1862, 47.—Decease, 1865, 2.—Memoir, 16.

SINCLAIR, A., elected Member, 1848, Apl., 24.



SINCLAIR, R., elected Member, 1847.—Council, 1849, Jan., 9.—1850, Jan., 5.

SINCLAIR, R. C., elected Member, 1857, 55.

SINGLETON, W., elected Honorary Member, 1856, 80.

SLATE, A., Original Member, 1847.—Council, 1848.—1849, Jan., 9.—1851, Jan., 8.—Vice-President, 1853, 7.—1854, 5.—1855, 5.

Axles, mistake to strengthen axle in middle in order to prevent breaking at ends, 1850, Oct., 7.—Suggestion for doing away with shoulder on axle, 10.

Blowing Engine, *Paper* on a blowing engine working at high velocities, 1850, July, 16.—Cylinder-blast better for cupolas than fan-blast, 24.

Blowing Engine, *Paper* on a new blowing engine working at high velocities, 1851, July, 37.

Canal Lift, *Paper* on a new equilibrium canal lift for transferring boats from one level to another without loss of water or of power, 1851, Oct., 17.—Safety of lift, 22.—Cost of lift and of ordinary locks, 23.

Expansion of Steam, indicator diagrams in Staffordshire district show very inferior action, 1849, July, 29.

Filter, Forster's, *Paper* on an improved water filter, 1854, 75.

Iron, time an important element in determination of tensile strength, 1850, Apl., 11.

Locomotive Boiler, advisable to diminish velocity of draught through tubes, 1849, July, 10.—Power absorbed by friction of air through tubes, 11.

Railway Axles, change from fibrous to crystalline not produced unless strained beyond elastic limit, 1849, Oct., 26.

Railway Carriage Elevator, perfect action of contrivance for stopping elevator from descending, 1848, Oct., 19.

Railway Carrying Stock, rolling hollow rectangular sole bars, 1851, Jan., 15.—Importance of diminishing dead weight, 17.

Safety Mine Apparatus, *Paper* on a safety apparatus for working mine shafts, 1854, 57.

Springs, tension carriage spring very unmechanical construction, 1850, Apl., 20.

Starting Apparatus, conical clutch found to stick, 1848, Apl., 14.

Ventilation of Colliery, collieries in North much greater extent and depth than in Staffordshire, 1849, July, 38.

SLATER, A., elected Graduate, 1872, 26.

SLATER, I., elected Member, 1859, 54.

Railway Carriages, long carriages objectionable because present workshops, turntables, &c., not large enough, 1857, 158.

SLAUGHTER, E., elected Member, 1853, 8.

Iron Manufacture, toughened cast-iron forms excellent material for engine cylinders, 1853, 32.

SLIDE-VALVE, BALANCED. *See* Balanced Slide-Valve.

- SLIDE-VALVE, EXPANSION. *See* Expansion Valve, 1856, 58.
- SMETHURST, J., elected Member, 1866, 103.
- SMITH, A., Rope Manufacture, improved wire-rope machine, 1862, 197.—  
Bending of wires in machine not sufficient to injure wire, 206.—Strength  
of steel and iron wire, 207.—Relative strength of steel and iron wire-rope,  
234.
- SMITH, C., elected Member, 1873, 46.
- SMITH, C. F. S., elected Member, 1859, 14.
- SMITH, E. F., elected Member, 1866, 265.
- SMITH, F., Ironworks, Round-Oak, *Paper* on the Round-Oak Ironworks, 1860,  
211.—Helve preferred to steam hammer for shingling, 221.
- SMITH, F. P., Wood Bearings, particulars of experiments, 1856, 30.—Success  
of wood bearings for screw shaft in "Himalaya," 31.—Rise of  
temperature in water surrounding bearing, 33.
- SMITH, G., elected Member, 1854, 110.
- SMITH, G. B., elected Member, 1854, 49.
- SMITH, G. F., elected Member, 1866, 18.
- SMITH, H. (Brierley Hill), elected Member, 1860, 90.
- SMITH, H. (Liverpool), elected Member, 1847.
- SMITH, H. (Westbromwich), Original Member, 1847.
- Railway Axles, experiments on fibrous iron cold-hammered until rendered  
crystalline, 1849, Oct., 24.
- Wrought-Iron Wheel, *Paper* on a solid wrought-iron wheel, 1849, Apl., 9.—  
Particulars of disc wheels at work, 18.—Cost of forging tyre on wheel less  
than putting on separate tyre, 19.—Wheel forgings all as sound as bars of  
piled iron, 20.
- SMITH, I., elected Member, 1858, 45.—Decease, 1869, 2.—Memoir, 17.
- Decimal Measure, want of a reliable wire-gauge, and standard plugs to test  
gauges in use, 1859, 132.
- Peat Fuel, suggestion for manufacture of gas in same manner as from wood  
in Germany, 1865, 158.
- Surface Condensers, wrought-iron pipes corroded by distilled water, while  
cast-iron not injured, 1863, 159.
- Ventilation, Mechanical, failure of plan of admitting fresh air above, and  
taking off foul air below, 1863, 205.—Great success of ventilation at  
St. George's Hall, Liverpool, 206.—Muir's ventilators, 206.—Chimney  
flues usually much too large, 207.—Impurities in town air, 207.
- Water Works, importance of meters in preventing waste, 1863, 189.—  
Intermittent supply with cisterns objectionable, 191.—India-rubber  
diaphragm-valves best for house taps, 191.
- Wood Bearings, brass bearing with wood plugs, successful for rolls when  
rolling cold thin sheet steel, 1858, 90.

SMITH, J. (Derby), elected Member, 1860, 14.

SMITH, J. (Wolverhampton), Steam Cultivation, very successful results, 1865, 86.—Rooting out weeds by deep ploughing, 87.

SMITH, J. T., elected Member, 1857, 55.

SMITH, M., elected Member, 1859, 14.

SMITH, M. H., elected Graduate, 1870, 126.

SMITH, N. H., elected Member, 1848, Apl., 24.

SMITH, R., elected Member, 1860, 90.

Ironworks, Round-Oak, slack from coal workings got rid of by using it for separate boilers, 1860, 220.

SMITH, T. T., elected Member, 1849, Apl., 32.

SMITH, W. (Dudley), elected Member, 1848.

Boiler Explosion, *Paper* on the recent boiler explosion at Dudley, 1848, June, 14.—Boiler not adapted for so high a pressure as worked at, 16.

Boiler, High-Pressure, *Paper* on high-pressure boilers and on boiler explosions, 1848, July, 11.—Supply of water in tubes below boiler, 15.

Condensation of Steam, *Paper* on the condensation of steam in the engines of the South Staffordshire iron district, and the improvements to be effected in them, 1850, Jan., 31.—*Supplementary Paper*, 1850, July, 4.—Engines now worked at much higher pressure than originally proportioned for, 11.—Engines frequently kept working when in need of repairs, 12.

Expansion of Steam, Fairbairn's expansion gear very simple and works well, 1849, July, 28.—Consumption very high in Staffordshire district from inferior fuel and waste of steam, 30.

Iron, crystallising effect of hammering puddled bar iron cold on end, 1850, Jan., 18.

SMITH, W. (Glasgow), elected Member, 1866, 265.

SMITH, W. (London), elected Member, 1857, 55.

Hoist Governor, very efficient under severe trials, 1858, 271.—Rack and pinion would be better than friction roller for driving governor, 272.

Marine Engine Governor, "storm" governor previously tried not very successful, 1859, 94.

Safety Escape Pipe, ordinary lead plugs oxidise in time, and become infusible, 1857, 181, 182.

Towing Canal Boats, early plan of towing with fixed wire-rope, 1869, 269.—Plan for passing locks, 269.

Wood Bearings, early use of wood bearings by millwrights for low velocities only, 1858, 87.

SMITH, W. (Woolston), Steam Cultivation, leading points in application of steam to cultivation, 1857, 73.—Each farmer should do his own ploughing, 74.—Success of steam cultivation, 75.

SMITH, W. F., elected Member, 1863, 246.

Tools, wider groove with angle of  $120^\circ$  better for planing machines, 1864, 226.—Stepped racks difficult to make sufficiently accurate, 226.

Tool and Holder, *Paper* on an improved tool and holder for turning and planing, 1866, 288.—Good surface left with round cutters, 301.—Cutting angles for different metals, 302.

Turning Tool, increase of speed of turning, 1872, 292.

Wheel Moulding, wood patterns objectionable, 1868, 248.

SMITH PRESSURE GAUGE. *See* Pressure Gauges, 1871, 281.

SMOKE PREVENTING VALVE, Prideaux's. *See* Furnace Valve, 1854, 111.

SMOKE PREVENTION, *Paper* on an apparatus for the prevention of smoke in steam boiler and other furnaces, by W. B. Johnson, 1857, 125.—Description of boiler with apparatus, 125.—Action of apparatus, 126.—Pyrometer, 127.—Pyrometer diagrams, 127.

*Discussion*.—Fairbairn, W., 129.—Johnson, W. B., 128, 129.

SNOWDON, T., elected Member, 1857, 202.

Blast-Furnace Gas, high chimney necessary to take off gases from closed-top furnace, 1860, 133.—Gases should be taken off as cool as possible, 133.

SOAMES, P., elected Member, 1871, 21.

SOKOLOFF, A., elected Member, 1859, 14.

SOLIDS, FLOW OF. *See* Flow of Solids, 1867, 60.

SOLLY, J., elected Member, 1853, 45.

SOLLY, N. N., Blast-Furnace Gas, gas taken off successfully from Willenhall furnaces, 1860, 269.—No danger from explosions if safety valves are provided on gas mains, 273.—Taking off gas removes much sulphur and other impurities from furnace, 274.

Blast-Furnace Tuyere, *Paper* on a gunmetal tuyere for blast furnaces, 1865, 256.—Durability of gunmetal tuyeres, 262.—Cost of gunmetal tuyeres, 262.

SOMERVILLE, W. C., elected Member, 1863, 58.

SOPER, W., Rifles, Breech-Loading, liability to "spitting" in the Martini and other constructions, 1871, 113.—Advantage of transverse breech-block, 113.—Rapidty of fire of Soper rifle, 114.—Advantage of cleaning barrel from the rear, 294.—Particulars of Soper rifle, 294.

SÖRENSEN, B., elected Member, 1858, 266.

SOUTH STAFFORDSHIRE Thick Coal. *See* Coal, South Staffordshire Thick, 1860, 91.

SOUTH YORKSHIRE Coal Mining. *See* Coal Mining, 1862, 68.

SPARROW, A., elected Member, 1865, 20.

SPARROW, W. M., elected Member, 1865, 54.

SPENCER, E., elected Member, 1866, 103.

SPENCER, J., elected Member, 1848, July, 20.

SPENCER, J. F., elected Member, 1859, 54.

Boiler, High-Pressure, *Paper* on a new construction of high-pressure steam boiler, 1859, 264.—Rapid raising of steam in fire engine, 273.—No objection to mechanical circulation, 273.

Railway Bridges, protection of iron from corrosion, 1861, 189.

Surface Condenser, better to have condensing water inside tubes, and steam outside, 1862, 107.—Particulars of working, 108.—India-rubber joints for tubes very satisfactory, 108.—Particulars of working, 109.—Corrosion of boilers stopped by changing water at intervals, 120, 121.

SPENCER, J. W., elected Member, 1867, 60.

SPENCER, T. (Newcastle), elected Member, 1854, 79.

Uchatius Cast Steel, *Paper* on the manufacture of the Uchatius cast steel, 1858, 146.—Transverse strength, 150.

SPENCER, T. (Westbromwich), elected Member, 1853, 8.

SPINNING MACHINERY FOR COTTON. *See* Cotton-Spinning Machinery, 1866, 199.

SPINNING MACHINERY FOR FLAX. *See* Flax-Spinning Machinery, 1865, 103.

SPITTLE, T., elected Member, 1864, 121.

SPON, E., Pressure Gauges, *Paper* on steam pressure gauges, 1871, 281.—Foster gauge not injured by being kept under pressure for long period, 288.—Small pocket-gauge indicating to 500 lbs., 288.—Great durability of india-rubber diaphragm, 290.—Spring gauge better than Bourdon gauge, 290.

SPOOLING MACHINE for Cotton. *See* Cotton Spooling, 1861, 54.

SPRAY, F. G., elected Member, 1857, 11.—Decease, 1859, 2.

SPRINGS, *Paper* on railway carriage and wagon springs, by W. A. Adams, 1850, Jan., 19.—Variation in weight of springs, 19.—Experiments on springs made from English and Swedish iron, 20.—Laminated springs, 20.—Wagon bearing springs, 22.—Carriage bearing springs, 24.—Buchanan's bearing spring, 25.—Adams' bow spring, 25.—Spiral bearing spring, 26.—Buffer and draw springs, 26.—External buffers, 27.—Conical spiral-spring buffer, 29.

*Discussion.*—Adams, W. A., 30.—Cowper, E. A., 30.—Fuller, W. C., 30.—Hodge, P. R., 30.—McConnell, J. E., 30.—Middleton, W., 29, 30.

SPRINGS, *Supplementary Paper* on railway carriage and wagon springs, by W. A. Adams, 1850, Apl., 14.—Description of improved springs and fittings, 15.—Deflection, 15.—Small spring, 16.—Table of experiments on deflection, 16.—Improved axlebox, 17.

*Discussion.*—Adams, W. A., 17, 18, 19, 20, 25.—De Bergue, C., 20, 25.—Henson, H. H., 25.—McConnell, J. E., 18, 19, 25, 26.—Ramsbottom, J., 26.—Robinson, H., 25.—Ross, J., 18.—Slate, A., 20.—Smith, H., 18.—Stephenson, R., 17, 18, 19, 26.—Wright, H., 19, 25.—Wright, J., 17, 18, 19, 26.



**SPRINGS, Paper** on improved india-rubber springs for railway engines, carriages, &c., by W. G. Craig, 1853, 45.—Tramplate, considerable deflection under load, 46.—Failure of steel springs for engines, &c., 46.—Description of india-rubber bearing springs, 47.—Wagon springs, 48.—Hydro-pneumatic spring, 48.—Pneumatic buffer, 49.—Advantages of india-rubber springs, 49.—Weight of india-rubber and of steel springs, 50.—Table of deflection of springs, 52.—Saving in cost of repairs, 53.

*Discussion.*—Adams, W. A., 54.—Allan, A., 54, 55.—Clift, J. E., 55.—Cowper, E. A., 55.—Craig, W. G., 53, 55, 56.—Slate, A., 54, 55, 56.—Wright, H., 53, 56.

**SPRINGS, Paper** on a new convex-plate laminated spring, by J. Wilson, 1857, 219.—Great weight of ordinary laminated springs, 219.—Description of new convex-plate springs, 220.—Centre clip, 221.—Principle of action of convex plates, 221.—Trials of convex-plate springs, 222.—Spring with ends of plates separated, 222.—Table of experiments, 223.—Saving in weight, 224.

*Discussion.*—Fairbairn, W., 224, 225, 226.—Ferne, J., 225.—McConnell, J. E., 225, 226.—Ross, J., 226.—Wilson, J., 224, 225.

**SPRINGS, Paper** on a new construction of railway springs, by T. Hunt, 1858, 160.—Separate action of each plate of laminated spring, 160.—Experiments on various forms of new spring, 161.

*Discussion.*—Allan, A., 162, 163, 164, 165.—Cowper, E. A., 163.—Laybourn, R., 165.—Prideaux, T. S., 165.—Spencer, T., 164.—Tomlinson, J., 163.—Whitworth, J., 163, 165.

**SPRING AND AXLEBOX, Paper** on an improved spring and axlebox for railway carriages, by W. B. Adams, 1855, 163.—Action of springs, 163.—Ordinary laminated spring, 164.—Improved spring, 164.—Slots for keeping plates parallel, done away with, 165.—Tapered plates, 165.—Reversed spring, 166.—Axlebox, 166.—Results of trials, 167.

*Discussion.*—Adams, W. B., 168, 169, 170.—Fairbairn, W., 168, 169, 170, 171.—Ramsbottom, J., 168, 169, 170.

**STABLEFORD, W.**, elected Member, 1862, 20.

**STABLER, J.**, elected Member, 1869, 276.

**STAMPS, PNEUMATIC, Husband's**, particulars of working, 1873, 143.

**STANFORTH, R.**, elected Member, 1848.

**STARTING APPARATUS, Paper** on a hydraulic starting apparatus, by P. R. Jackson, 1848, Apl., 12.—Contrivances for connecting and disengaging heavy machinery without sudden shocks, 12.—Bodmer's plan with levers and segments lined with copper, 12.—Hydraulic pressure applied to segments, 12.—Construction and action of hydraulic starting apparatus, 12.—Safety-valve to prevent too great pressure, 12.—Segments withdrawn out of contact by vacuum, 13.

## STARTING APPARATUS (continued).

*Discussion.*—Cowper, E. A., 13, 14, 15. — Crampton, T. R., 14, 15.—Fothergill, B., 13, 14, 15.—Jackson, P. R., 13, 15.—McConnell, J. E., 13, 14, 15.—Slate, A., 14.—Stephenson, G., 13, 15.

STARTING APPARATUS, *Paper* on a starting and disengaging apparatus, by J. Hick, 1849, Jan., 16.—Modifies shock of sudden connection or disconnection of driving power, 16.—Means of instantaneous disconnection to prevent accidents, 17.—Expanding segments pressed out by right-and-left-handed screws, 18.—Segments lined with copper for renewal, 18.—Modifications of apparatus, 19.

*Discussion.*—Buckle, W., 20.—Cowper, E. A., 20.—Fothergill, B., 21.—Hodge, P. R., 21.—McConnell, J. E., 20, 21.—Slate, A., 21.

STATION BUFFER. *See* Buffer, 1848, July, 17.—1849, Jan., 10.

STEAM BOILER. *See* Boiler.

STEAM BREAK. *See* Break, 1859, 230.—1870, 21.

STEAM CONDENSATION. *See* Condensation, 1850, Jan., 31.

STEAM CONDENSER. *See* Condenser.

STEAM CORN MILL, Floating. *See* Corn Mill, 1858, 155.

STEAM CRANE. *See* Crane, 1859, 168, 238.

STEAM CULTIVATION. *See* Agricultural.

STEAM DASH WHEEL. *See* Dash Wheel, 1856, 239.

STEAM DREDGERS. *See* Dredgers, 1864, 147.—1867, 192.

STEAM ENGINE. *See* Engine.

STEAM ENGINE GOVERNOR. *See* Governor.

STEAM EXPANSION. *See* Expansion, 1849, July, 21.

STEAM HAMMER. *See* Hammer.

STEAM ISOLATED, Expansion of. *See* Expansion, 1852, 131.

STEAM JET, *Paper* on a steam jet for exhausting air &c., and the results of its application, by C. W. Siemens, 1872, 97.—Description of improved steam jet, 98.—Conclusions from experiments, 99.—Giffard's injector, 99.—Zeuner's experiments on steam jet, 100.—Tables of results of experiments, 101, 102.—Pneumatic despatch tubes, 103.—Raising water, 105.—Evaporation of sugar, 107.—Blower for gas producers, 109.

*Discussion.*—Fenby, J. B., 114.—Olrick, L., 112.—Robinson, J., 116.—Siemens, C. W., 110, 113, 115.

STEAM PILE DRIVER. *See* Pile Driver.

STEAM PRESSURE GAUGE. *See* Pressure Gauge.

STEAM PUMP, Direct-Acting. *See* Pump, 1852, 174.

STEAM RAILWAY BREAK. *See* Break, 1859, 230.—1870, 21.


STEAM RIVETING MACHINE. *See* Riveter, 1856, 134.—1865, 129.—1872, 195, 196.

STEAM ROAD ROLLER. *See* Road Roller, 1869, 101.—1870, 109.

STEAM STEERING ENGINE. *See* Steering Engine, 1867, 267.

STEAM, SUPERHEATED, *Paper* on the application of superheated steam in marine engines, by J. Penn, 1859, 195.—Howard's first trial of superheated steam, 195.—Source of advantage in superheating steam, 196.—Superheating steam better than using steam-jacket, 197.—Description of superheating apparatus, 198.—Saving from use of superheating apparatus, 199.—Mode of construction, 199.—Provision against accidents, 200.

*Discussion.*—Adamson, D., 207.—Cowper, E. A., 203, 208.—Everitt, G. A., 207.—Fothergill, B., 209.—Fryer, A., 208.—Harman, H. W., 202.—Joy, D., 206.—Longridge, R. B., 206.—Maudslay, H., 209.—Morrison, R., 205, 206, 207.—Penn, J., 201, 202, 205, 206, 207.—Spencer, J. F., 203, 210.—Ward, W. S., 202.

STEAM, SUPERHEATED, *Paper* on the application of superheated steam, by J. N. Ryder, 1860, 22.—Parson and Pilgrim's arrangement for superheating, 22.—Saving from use of superheated steam, 23.—Chemical experiments on superheated steam, 23.—Patridge's superheating apparatus, 25.—Economy of superheating, 26.—Area of superheating surface, 26.— General advantages of superheating, 27.

*Discussion.*—Bramwell, F. J., 30, 34, 37.—Cowper, E. A., 29, 34.—Johnson, W. B., 29, 34, 37.—Kennedy, J., 37, 38.—Markham, C., 29.—Maudslay, H., 33.—Pilgrim, T., 36, 37.—Robinson, J., 30.—Siemens, C. W., 30.—Wethered, J., 35, 38.

STEAM TRAVELLING CRANE. *See* Crane, 1854, 96.

STEAVENSON, A. L., Cleveland Iron District, Fowler's clip-drum used for pumping, 1871, 197.—Guibal fan for ventilating, 197.

Ventilation of Mines, principle of varying capacity superior to centrifugal action, 1869, 149.

STEEL, BESSEMER, *Paper* on the manufacture of cast steel and its application to constructive purposes, by H. Bessemer, 1861, 133.—Early manufacture of cast steel, 133.—Process of making ordinary steel, 134.—Imperfections of malleable iron, 135.—Conditions requisite for general use of steel, 136.—Process of making Bessemer steel, 137.—Lining of converter, 137.—Process of conversion, 138.—Casting, 139.—Loss on weight of crude iron, 140.—Experiments on tensile strength, 141.—Steel plates for boilers and fireboxes, 142.—Application to manufacture of ordnance, 144.—Cost of steel-making plant, 145.

*Discussion.*—Adamson, D., 149, 153.—Armstrong, Sir W. G., 146, 148, 154, 157.—Bessemer, H., 146, 149, 152, 155.—Fothergill, B., 151.—Harman, H. W., 151.—Longsdon, R., 157.—Maudslay, H., 153.—Richardson, W., 150, 151.

STEEL MANUFACTURE, *Paper* on improvements in steel manufacture, and its application to railway and other purposes, by T. W. Dodds, 1857, 162.—

## STEEL MANUFACTURE (continued).

Ordinary process of conversion, 162.—New process of conversion, 163.—Processes for hardening surface of articles, 163.—Saving to be effected by steeling surface of railway bars, 164.—Description of converting furnace, 166.—Various applications of process, 167.

*Discussion.*—Dodds, I., 170.—Dodds, T. W., 168, 169, 170, 171.—Humber, W., 170, 171.—Lloyd, Samuel, Jun., 169, 171.—McConnell, J. E., 168, 169.—Ramsbottom, J., 168.—Whitworth, J., 168, 169, 171.

STEEL RAILS AND ARMOUR PLATES, *Paper* on the manufacture of steel rails and armour plates, by J. Brown, 1861, 121.—Iron rails with hardened tops, 121.—Manufacture of rails from Bessemer steel, 122.—Armour plates, 123.—Rolled plates superior to hammered, 124.—Sizes of armour plates, 124.—Mode of manufacture, 124.—Arrangement of plate mill, 125.

*Discussion.*—Armstrong, Sir W. G., 126, 128, 130.—Brown, J., 126, 127, 128, 129, 130.—Cochrane, A. B., 128.—Fenton, J., 127.—Fothergill, B., 128.—Kennedy, Col., 127, 128, 129.—Lloyd, Sampson, 127.—Williams, R., 128.

STEEL, STRENGTH OF, *Paper* on the strength of steel containing different proportions of carbon, by T. E. Vickers, 1861, 158.—Tensile strength, mode of testing, 158.—Table of experiments, 159.—Transverse strength, 160.—Table of experiments, 161.—Further experiments on steel and iron axles, 162.—Steel less injured by constant vibration than iron, 163.—Transverse and tensile strength of various steels, 164.—Steel bells not rendered brittle by frost like bronze bells, 164.—Experiments on steel disc-wheels, 165.—Specific gravity of steels, 165.

*Discussion.*—Armstrong, Sir W. G., 168, 169.—Fothergill, B., 168.—Kennedy, Col., 168.—Maudslay, H., 167.—Riley, E., 169.—Vickers, T. E., 167, 168, 169.—Williams, R., 168.

STEEL TYRES, BANKS', *Paper* on Banks' steel tyres, by B. Fothergill, 1848, Apl., 21.—Comparative cost and durability of Staffordshire tyres steeled and Low Moor tyres, 21.—Results of steeling tyres a second time, 21.—Steel segments inserted in groove turned in tyre when wheel re-turned, 21.—Durability of steeled tyres on locomotive, 21.

*Discussion.*—McConnell, J. E., 22.—Peacock, R., 22.—Ramsbottom, J., 22.—Stephenson, G., 22.

STEEL TYRES, MANUFACTURE OF, *Paper* on an improved mode of manufacture of steel tyres, by J. Ramsbottom, 1866, 186.—Mould for casting, 186.—Horizontal duplex hammer, 187.—Punching centre hole, 188.—Swing frame, 189.—Hammering on beck anvil, 189.—Rolling, 190.—Rapidity of production, 190.—Saving of waste of material, 191.—Strength of tyres, 192.

*Discussion.*—Ashbury, J. L., 192.—Bramwell, F. J., 196.—Fairbairn, W., 196.—Kennedy, Col., 192.—Ramsbottom, J., 193, 196.—Whitworth, J., 197.

STEEL, UCHATIUS, *Paper* on the manufacture of the Uchatius cast steel, by T. Spencer, 1858, 146.—Comparison of steel with wrought iron, &c., 146.—Converting process of making steel, 147.—German puddling process, 148.—Uchatius process, 148.—Granulating tank, 148.—Action in crucible, 149.

*Discussion.*—Anderson, J., 153.—Cowper, E. A., 153.—Fairbairn, W., 150, 151, 154.—Lenz, A., 152, 153.—Pilkington, R., 154.—Prideaux, T. S., 151.—Smith, W., 152.—Spencer, T., 150, 151, 154.—Whitworth, J., 150, 151, 154.

STEERING ENGINE, STEAM, *Paper* on the steam steering engine in the Great Eastern steamship, by J. M. F. Gray, 1867, 267.—Inefficiency of hand steering, 267.—Conditions required for Great Eastern steering apparatus, 270.—Description of steering gear, 270.—Engine, 271.—Automatic stop-valve, 271.—Action of steering wheel, 272.—Resistance to sudden strain, 273.—Rudder indicator, 274.—Safety clutch for connecting the steering wheel, 275.—Shafting, 276.—Prevention of accumulation of water in cylinders, 277.—Gear connecting engine to rudder-shaft, 277.—Great success of steering engine, 278.

*Discussion.*—Bramwell, F. J., 281, 285, 286, 287.—Cowper, E. A., 283.—Gray, J. M. F., 281, 283, 284, 285, 286, 287.—Naylor, W., 282.—Siemens, C. W., 279, 285.

STENSON, F., elected Member, 1869, 276.

STENSON, W., elected Member, 1855, 97.

STENSON, W. T., elected Member, 1868, 212.

STEPHEN, J., Boiler, *Paper* on a steam boiler with combined internal and external furnaces, 1856, 213.

STEPHENS, J. C., elected Member, 1866, 103.

STEPHENSON, GEORGE, Original Member, 1847.—President, 1847.—1848.—Decease, 1848, Oct., 3.

Monument to, 1852, 34.

Notice of the life and character of the late George Stephenson, first President of the Institution, by J. S. Russell, 1848, Oct., 3.—Introduction of locomotives upon railways due chiefly to original genius of George Stephenson, 4.—Valuable results of his practical self-education, 4.—His original invention of the safety lamp, 5.—Chief inventor of locomotives and railways, 6.—Continuous wrought-iron rail necessary for speed of locomotives, 7.—Disadvantages from want of early scientific training, 8.—Eminently a practical man, but also a bold theorist, 8.—Special attention to scientific education for his son Robert, 9.—Number of his pupils distinguished in the profession, 10.

*Discussion.*—Fothergill, B., 11, 12.—Geach, C., 10.—McConnell, J. E., 12.



STEPHENSON, GEORGE (continued).

Rotary Engine, *Paper* on the fallacies of the rotary engine, 1848, July, 3.—

Failure of Beale's rotary engine in steamboat at Yarmouth, 5.

Safety Buffer, momentum of train must be taken up somewhere and cause shock, 1848, Apl., 20.

STEPHENSON, G. R., elected Member, 1868, 43.

STEPHENSON, ROBERT, Original Member, 1847.—President, 1849, Jan., 7.—

1850, Jan., 4.—1851, Jan., 8.—1852, 8.—1853, 7.—Decease, 1860, 2.

Decease, notice of, 1859, 245.

Expansion in Locomotives, experiment showing importance of keeping cylinder heated, 1852, 84.—Locomotive with cylinders inside smokebox, 85.

Institution, donation of £100, 1850, July, 3.

Nasmyth Girders, cast iron better than wrought iron for employment as arch, 1849, Oct., 30.—Parallel box preferable to arch form for uniform leverage of compression and tension, 31.

Permanent Way, important consideration whether limit of crushing resistance is reached in rails, 1849, Apl., 30.—Serious objection if rail requires taking out for replacing a broken chair, 31.

Railway Axles, doubt whether fibrous iron is changed to crystalline by vibration, 1849, Oct., 22.—Experiments on axles by slow pressure do not correspond to strain from violent blows on rails, 22.—Importance of element of time in fracture by concussion, 23.—Axles broke generally close to wheel from sudden change of elasticity at that point, 23.—Wrought iron shown to be elastic like india-rubber, by stretching and recovery of lifting bars for Britannia tubular bridge, 25.—Iron cooled suddenly acquired crystalline grain, but if rolled while cooling became fibrous, 26.

Railway Axles, no difference in structure perceptible under microscope, between fibrous and crystalline iron, 1850, Apl., 6.—Fracture of axles illustrated by vibrating string, 7.—Tensile strength of crystalline boiler plates used in Britannia bridge, greater than that of fibrous plates, 10.—Testing machines for tensile strength liable to error, 10.—Limit of elasticity of bar iron, 11.—Hydraulic press liable to error in testing tensile strength, 13.—Experiments on ultimate strength of wrought iron, 13.

Railway Chair, tendency to split ends of rails, 1853, 16.—Joint chair, desirable to have few parts, 1849, Apl., 6.—Great importance of some secure fastening for railway chairs, 6.

Remarks as President, 1849, Apl., 3.—Want of energy hitherto for development of mechanical arts and sciences, 3.—Necessity for members to co-operate with energy in sustaining the Institution, 41.—Remarks, 1853, 6, 8.

STEPHENSON, ROBERT (continued).

Wrought-Iron Wheel, preferable for tyre to be separate, because less durability, 1849, Apl., 18.—Wrought-iron wheels better than cast-iron for rapid railway travelling, 19.—Rails on rigid block road wear much faster than on elastic road, and tyre likely to wear faster on rigid wheel, 19.—Solid wheel very good, and a triumph in forging, 20.

STEVENSON, J., elected Member, 1866, 103.

STEVENSON, R., elected Member, 1867, 60.

STEWART, C. P., elected Member, 1859, 248.—Council, 1862, 13.—1865, 19.—1868, 19.—1871, 20.—1873, 24.

Screwing Machine, *Paper* on Sellers' screwing machine, 1861, 231.

STEWART, J., elected Member, 1851, Apl., 45.

ST. GEORGE'S HALL, Liverpool, Mechanical Ventilation and Warming. *See* Ventilation, Mechanical, 1863, 194.

STIRLING, J. D. M., Iron Manufacture, *Paper* on iron and some improvements in its manufacture, 1853, 19.—Alloy of brass and iron, 28.—Wheel tyres made of compound bloom, with hard wearing surface, 30.—Rails with hardened surface, 31.—Cost of toughened cast-iron, 33.

STIRLING, P., elected Member, 1867, 234.

STOKES, C. L., elected Member, 1857, 11.—Decease, 1865, 2.—Memoir, 17.

STOKES, J. F., elected Member, 1864, 59.

STONE-BREAKING MACHINE, Blake's, *Paper* on a machine for breaking limestone and ore at Kirkless Hall Iron Works, by J. Lancaster, 1864, 20.—Description of machine, 20.—Toggle-joint, 20.—Adjustment of movable jaw, 21.—Working speed, 22.—Cost of working, 22.

*Discussion.*—Cowper, E. A., 24, 29, 31.—Lancaster, J., 24, 28, 29.—Lloyd, Samuel, 29.—Lloyd, W., 28, 29.—Marsden, H. R., 24, 25, 26, 27, 28, 29, 30, 32.—Napier, R., 23, 24, 25, 26, 28, 30, 32.—Ramsbottom, J., 31.—Wilson, J. C., 27.

STONE-CRUSHING MACHINERY, *Paper* on machinery for crushing stone for macadamising roads, by C. G. Mountain, 1860, 234.—Experimental crushing machine, 235.—Experiments on various forms of crushing rollers, 236.—Arrangement of mill and machinery finally erected, 238.—Feed apparatus, 238.—Elevator and riddle for crushed stone, 239.—Details of second permanent mill and machinery, 240.—Durability of crushing rolls, 241.—Proportions of finished stone, gravel, &c., produced, 242.—Consumption of coal, 242.—Indicator diagrams, 242.

*Discussion.*—Cowper, E. A., 245.—Dunn, T., 244.—Ferne, J., 245.—Kennedy, J., 246.—Lloyd, Samuel, 246.—Mountain, C. G., 244, 245, 246.—Richardson, W., 244.—Wrigley, F., 245.

STONEHOUSE, M., elected Member, 1873, 250.

STOREY, J. H., elected Member, 1863, 58.

Indicator, Continuous, *Paper* on Ashton and Storey's steam-power meter and continuous indicator, 1871, 75.

STOREY, T. R., elected Honorary Member. 1863, 247.

STOVES, HOT-BLAST. *See* Hot-Blast Stoves, 1859, 82.—1860, 54.—1870, 62, 94.

STRENGTH OF STEEL. *See* Steel, 1861, 158.

STRONG, J. F., elected Member, 1854, 79.—Re-elected, 1862, 314.

Railway Bridge Piers, *Paper* on the apparatus used for sinking piers for iron railway bridges in India, 1863, 16.—Dredgers not successful for excavating sand inside cylinders, 25.—Cost of sinking cylinders, 26.—Great depth of sand, 27.—Failure of cylinders while sinking in heavy flood, 27.—Great strength of brickwork, 28.—Experiment on supporting power of sand, 30.

STROUDLEY, W., elected Member, 1865, 54.

STRUVE'S VENTILATING MACHINE, 1869, 79, 146.

STRYPE, W. G., elected Member, 1873, 88.

STUBBS, T., elected Member, 1870, 61.—Decease, 1871, 2.—Memoir, 18.

SUBJECTS FOR PAPERS. *See* Papers, Subjects for.

SUBMARINE TELEGRAPH CABLES. *See* Telegraph Cables, 1862, 211.—1867, 20.

SUEZ CANAL DREDGERS. *See* Dredgers for Suez Canal, 1867, 192.

SUGAR EVAPORATOR, *Paper* on an improved sugar evaporating apparatus, by R. Harvey, 1856, 179.—Battery evaporator, 179.—Description of Bour pan, 179.—Wetzel pan, 180.—Rapidity of boiling with Bour pan, 181.

*Discussion.*—Harvey, R., 181, 183.—Johnstone, J., 182, 184.—

Whitworth, J., 184.

SUMMER MEETINGS OF INSTITUTION :—

Birmingham, 1860, 89.

Cornwall, 1873, 87.

Dublin, 1865, 101.

Glasgow, 1856, 125.—1864, 121.

Leeds, 1859, 133.—1868, 103.

Liverpool, 1863, 113.—1872, 119.

London, 1851, June, 3.—1862, 93.

Manchester, 1857, 85.—1866, 103.

Middlesbrough, 1871, 117.

Newcastle, 1858, 125.—1869, 119.

Nottingham, 1870, 125.

Paris, 1867, 59.

Sheffield, 1861, 109.

SUMNER, W., elected Member, 1861, 53.

SUPERHEATED STEAM. *See* Steam, Superheated, 1859, 195.—1860, 22.

SURFACE CONDENSER. *See* Condenser, Surface.

SUSPENSION BRIDGE. *See* Bridge, 1847, Oct., 1.—1870, 249.

SUTTON, W., elected Honorary Member, 1853, 45.

SWANN, J. V. R., elected Member, 1870, 126.

SWINDELL, J. E., elected Member, 1860, 90.

Blast Furnaces, dimensions of Staffordshire furnaces, 1864, 176.—Failure of plan for combustion of gas in furnace throat, 181.—Tensile strength of cold-blast cast-iron, 183.

SWINDELL, J. S. E., elected Member, 1864, 121.

Ventilating Fan, *Paper* on Guibal's ventilating fan employed at the Homer Hill Colliery, 1869, 78.—Particulars of working of Guibal fan, 92.—Closing top of ventilating shaft, 97.

Ventilation of Mines, working of Guibal fan at Homer Hill Colliery, 1869, 149.

SWINGLER, H., elected Member, 1867, 60.

SWINGLER, T., elected Member, 1859, 97.

SWITCH. *See* Railway Switch.

SYMINGTON, W. W., elected Member, 1872, 119.

## T.

TANGYE, J., elected Member, 1861, 14.

Hydraulic Shears and Punch, *Paper* on a hydraulic shears and punch, 1862, 341.—Durability of cutters of shears, 345.—Weight and lifting power of jack, 346.

TANNETT, T., elected Member, 1859, 54.

TAYLEUR, E., Original Member, 1847.

TAYLOR, C. D., elected Member, 1873, 250.

Tin Stream Works, *Paper* on the Tin Stream Works in Restranguet Creek, near Truro, 1873, 155.

TAYLOR, G., elected Member, 1861, 211.

TAYLOR, G., Jun., elected Member, 1859, 97.

TAYLOR, JAMES (Birkenhead), elected Member, 1858, 266.

TAYLOR, JAMES (Leeds), elected Member, 1858, 45.—Decease, 1860, 2.

TAYLOR, JOB, Coal, South Staffordshire Thick, yield of coal per acre, 1860, 117.—"Long wall" working as liable to accidents as "rib and pillar," 118.

TAYLOR, JOHN (Manchester), elected Member, 1849, Jan., 9.

TAYLOR, JOHN (Nottingham), elected Member, 1873, 88.

TAYLOR, JOHN, Jun., elected Member, 1862, 47.

TAYLOR, JOSEPH, elected Member, 1867, 234.

TAYLOR, R., elected Member, 1862, 314.

Engines, Portable, for Mining, Cornish engines often moved from mine to mine. 1873, 184.—Portable engines useful for temporary work, but

## TAYLOR, R. (continued).

condensing engines better for regular work, 185.—Much earthy matter in Cornish mine coal, 185.—Dressing of ashes at Pontgibaud, 186.—Very high duty of Cornish engines at Gwennap, 190.—Single-flued boiler better than double-flued, 190.

Mining District of Cornwall, metallic minerals chiefly at junction of granite and killas, 1873, 109.—Lodes contain mostly tin at greater depths, even though copper above, 110.—No practical limit to depth of mines, 110.—Great heat in lower levels of deep mines, 110.—Lead mines of district not thoroughly worked yet, 111.—Iron mines yielding brown hæmatite now becoming important, 112.—Origin of cavities in lodes, 116.—Change of position of cavity from falling in of roof, 117.—Cornish iron ore must be stamped and washed to get rid of silicious matter, 117.

Ore-Dressing Machinery, Cornish ore-dressing till recently very crude, 1873, 137.—Erection of first jigging and crushing machines, 138.—Blake's stone-breaker cheaper in work than cylinder crushers, 139.—Husband's pneumatic stamps a great improvement, 139.—Important not to stamp tinstuff finer than necessary, 140.—Removal of iron pyrites from tin ore by calcining, 140.—Collom's jigger very useful for lead and copper ores, 141.—Propeller-knife buddle very economical and efficient for lead and tin ores, 141.

Tin Stream Works, ancient stream works, 1873, 162.—Former attempts at working under Restrouguet Creek, 163.—Same trams used throughout workings and drawn to surface, 164.—Dressing the tin-gravel, 164.—Success of Collom's jigger and of propeller-knife buddle, 165.—Application to lead dressing, 166.

TAYLOR, S., elected Member, 1868, 104.—Decease, 1872, 2.—Mémorial, 21.

TAYLOR, T. J., elected Member, 1858, 266.—Decease, 1862, 3.—Mémorial, 18.

Mining Machinery, *Paper* on the progressive application of machinery to mining purposes, 1859, 15.—Cost of maintenance of rope, and of raising coal from different depths, 35.—Difficulty of applying mechanical ventilators instead of furnaces, 37.—Great difference in value of slack coal, 41.

TAYLOR WATER METER. *See* Water Meter, 1853, 142.

TEAGUE, W., elected Member, 1872, 119.

TEETH OF WHEELS, *Paper* on the formation of the teeth of the drivers of pin wheels, by F. Bashforth, 1848, Apl., 4.—Revolving cutter to shape teeth, 4.—Cutter same size as pins of pin-wheel, 4.—Pins made with external revolving tube, 4.

*Discussion.*—Buckle, W., 5.—Cowper, E. A., 5.—Fothergill, B., 5.—McConnell, J. E., 4, 5.

TELEGRAPH CABLES, *Paper* on the construction of submarine telegraph cables, by F. Jenkin, 1862, 211.—General construction of cables. 211.—



## TELEGRAPH CABLES (continued).

Conductivity of copper wire, 211.—Copper conducting strand, 213.—Gutta-percha and india-rubber for insulating, 214.—Serving with hemp yarns, and sheathing with iron wire, 217.—Examples of cables, 218.—Siemens cable, 219.—Sheathing machine, 220.—Strength, &c., of cables, 221.—Tables of cables already laid, 224, 225.

*Discussion.*—Armstrong, Sir W. G., 226, 228, 229, 241.—Cowper, E. A., 230, 232.—Everitt, G. A., 232.—Grantham, J., 233.—Haggie, P., 236.—Hawksley, T., 237.—Jenkin, F., 226, 232, 235, 239.—Pole, W., 235, 237.—Russell, J. S., 231, 235.—Russell, N. S., 230.—Shears, W., 230.—Siemens, C. W., 226, 227, 228, 229, 232, 234, 236, 237.—Smith, A., 234.

TELEGRAPH CABLE Covering Machine. *See* India-rubber Covering Machine, 1860, 137.

TELEGRAPH MACHINERY, *Paper* on the paying-out and picking-up machinery employed in laying the Atlantic telegraph cable, by G. Elliot, 1867, 20.—Disposition of cable on board "Great Eastern" steamship, 20.—Tanks, 21.—Coiling cable into tanks, 21.—Length of cable, 22.—Paying-out machinery, 22.—Self-adjusting friction breaks, 24.—Dynamometer, 25.—Picking-up motion of paying-out drum, 26.—Length of cable paid out and time of laying, 28.—Picking-up machinery for broken 1865 cable, 29.—Calculated picking-up in single bight, 30.—Grapnel, 31.—Dynamometer, 31.—Picking-up machine, 31.—Process of grappling, 33.—Failure of first raising, 34.—Actual successful raising, 34.

*Discussion.*—Cowper, E. A., 42.—Fairbairn, W., 39, 41.—Penn, J., 44.—Siemens, C. W., 35, 40.—Wright, J. T., 40.—Wynne, F. G., 42.

TELESCOPE, EQUATORIAL, *Paper* on an equatorial motion for telescopes, by T. Richards, 1855, 137.—Ordinary arrangement of equatorial telescope, 137.—Description of new arrangement, 138.—Adjustment by finder, 138.—Water float for traversing telescope, 139.

*Discussion.*—Hodge, P. R., 144.—Hopkins, T., 142, 143.—Lloyd, S., Jun., 144.—McConnell, J. E., 142, 143, 144.—Osler, A. F., 143.—Wills, W. R., 144.

TENNANT, C., elected Member, 1864, 271.

TENNANT, J., elected Honorary Member, 1864, 271.

THIERRY, E., elected Member, 1860, 14.

THOMAS, J. L., elected Member, 1867, 19.

THOMAS, T., elected Member, 1864, 121.

THOMPSON, I., elected Member, 1848, July, 20.

THOMPSON, J., elected Member, 1851, July, 45.

THOMPSON, J. T., elected Member, 1857, 232.

THOMPSON, R., elected Member, 1857, 11.

THOMPSON, T. J., Gas Lighting for Trains, no danger of water splashing over from gasholder, 1857, 254.—Cost of gas, 257.

THOMPSON, W., elected Member, 1862, 93.

Marine Engines, single-cylinder engines, great shock on valve gear, 1872, 164. — Compound engine with cylinders coupled at 120°, 165. — No great advantage from use of steam-jacket or expansion valves, 174.

THOMSON, D., Double-Cylinder Pumping Engines, *Paper* on double-cylinder pumping engines, 1862, 259. — Pressure at end of stroke more than due to theoretical expansion, 271. — Experiments on different degrees of expansion, 285.

THOMSON, G., elected Member, 1852, 191.

Blast Furnaces, length of time materials are kept in furnace, 1864, 261.

THOMSON, J., elected Member, 1868, 104.

THOMSON, J. B., elected Member, 1849, Apl., 32.

THOMSON, W., Surface Condenser, rapid stream of water desirable in condenser, 1856, 192.

THOMSON, W., Jun., elected Member, 1858, 12.

THOMSON, W. S., elected Member, 1870, 228.

THORMAN, R., elected Member, 1848.

THORN, A., elected Member, 1865, 102.

THORNEWILL, R., elected Member, 1868, 104.

THORNEYCROFT, G. B., Axles, value of parallel axles in preventing deflection of wheels, 1850, Oct., 13.

THORNEYCROFT, T., elected Member, 1850, Jan., 5.

Axles, *Paper* on the form of shafts and axles, 1850, July, 35.

*Supplementary Paper* on the forms of railway axles, 1850, Oct., 4.—Danger from axle bending at centre, 6.

THORNTON, F. S., elected Honorary Member, 1864, 271.

THORNTON, R., elected Member, 1848, Apl., 24.

THORNTON, S., elected Member, 1847.

Ventilation, *Paper* on Watson's ventilating apparatus for buildings, &c., 1857, 259.

THRATTLE VALVE, Allen. *See* Governor, 1873, 47.

THURGOOD, E. C., elected Graduate, 1871, 65.

THWAITES, R., elected Member, 1861, 211.

TICKLE, J., elected Member, 1865, 219.

TIERNAY, J. B., elected Member, 1849, Jan., 9.

TIJOU, W., elected Member, 1862, 20.

TILGHMAN, B. C., Ship Model Machine, chemical composition of paraffin, 1873, 214.

TIMBER, PRESERVATION, *Paper* on the preservation of timber by creosoting, by J. E. Clift, 1851, Oct., 10.—Structure of wood; dry rot, 10.—Different processes for preserving, 11.—Action of creosote, 11.—Results of use of creosoted timber, 12.—Process of creosoting, 13.

## TIMBER, PRESERVATION (continued).

*Discussion.*—Bethell, J., 15, 16, 17.—Clift, J. E., 15, 16.—Shipton, J. A., 17.—Slate, A., 16.

TIMBER, PRESERVATION, *Paper* on Boucherie's process for the preservation of timber, by J. Reid, Jun., 1856, 196.—Principle of process, 196.—Mode of carrying out, 197.—Preserving solution, 198.—Conclusions from results of process, 199.

*Discussion.*—Fothergill, B., 200.—Reid, J., 200, 201.—Russell, J. S., 200.—Scott, M., 201.—Whitworth, J., 200, 201.

TIN AND COPPER MINING. *See* Mining, Cornwall, 1873, 89.—Ore-Dressing Machinery, 119.

TIN SMELTING WORKS, Bolitho's, 1873, 233.

TIN STREAM WORKS, *Paper* on the tin stream works in Restranguet Creek, near Truro, by C. D. Taylor, 1873, 155.—Old working in the creek, 155.—Commencement of present workings, 156.—Sinking iron shaft in the creek, 156.—Arrangement of workings, 157.—Heavy timbering required, 158.—Stripping or removing the tin gravel, 158.—Inflammable gas given off by mud and tin bed, 159.—Falling mud exhausts air very fast, 159.—No water comes through mud from the creek, 160.—Dressing the tin-stuff, 160.—Variation in thickness and produce of tin bed, 161.

*Discussion.*—Cochrane, C., 165.—Bramwell, F. J., 166.—Taylor, R., 162, 166.

TINGLEY COLLIERY, holing all done by machine, 1868, 158.

TIPPING, L., elected Member, 1861, 53.

TOLMÉ, J. H., elected Member, 1862, 93.

TOMKINS, E., elected Member, 1873, 25.

TOMLINSON, E., elected Member, 1863, 113.

TOMLINSON, J., Jun., elected Member, 1857, 11.

Boiler, Cast-Iron, evaporative power of Miller boiler, 1871, 274.—Doubtful whether circulating tubes of much use, 275.

Coal-Burning Locomotive, *Paper* on the burning of Welsh steam coal in locomotive engines, 1858, 274.—Evaporative duty less at high speeds, 286.—Newcastle coal requires more air for combustion than Welsh coal, 286.—Cost of coal and of coke, 287.—Welsh steam coal contains very little sulphur, 290.—Dimensions of firebars, 292.

Injector, will not raise supply water more than 5 ft., 1861, 230.

Pressure Gauge, compressed-air gauge very sensitive and reliable, 1859, 184.

Safety Valve, importance of periodical examination and cleaning of valves, 1865, 232.

TONKS, E., elected Member, 1867, 60.

TOOLS, HEAVY, *Paper* on improvements in heavy tools for general engineering and iron shipbuilding work, by J. Fletcher, 1864, 189.—General

# TOOLS, HEAVY (continued).

improvement in tools and machinery of late years, 189.—Lathe for long shafts and screws, 192.—Lathe for large crank shafts, 193.—Planing machine, 194.—Duplex planing machine, 197.—Slotting machine, 198.—Punching and shearing machine, 199.—Multiple drilling machine, 201.—Nut-making machine, 204.—Bolt-heading machine, 207.

*Discussion.*—Adamson, D., 214, 222, 224.—Birkel, J. J., 219, 225.—Fleet, T., 217.—Fletcher, J., 209, 210, 211, 212, 213, 218, 219, 220, 221, 222, 223, 224, 225, 227.—Kennan, J., 211, 219, 220.—Manning, J., 222.—Maudslay, H., 211.—McLellan, W., 210.—Napier, R., 209, 210, 212, 218, 220, 225, 228.—Neilson, W. M., 220.—Richardson, W., 221.—Robson, N., 223.—Smith, W. F., 221, 226.—Vernon, J., 213, 223.

**TOOL AND HOLDER**, *Paper* on an improved tool and holder for turning and planing, by W. F. Smith, 1866, 288.—Round and triangular cutters, 288.—Objections to ordinary diamond-pointed tool, 289.—Description of improved tool holder, 290.—Angles of improved cutter, 291.—Mechanical grinding, 293.—Advantages of improved tool, 294.

*Discussion.*—Bramwell, F. J., 302.—Cowper, E. A., 298, 300.—Fenby, J. B., 299.—Lloyd, Sampson, 298, 301, 302.—Murphy, J., 298.—Robinson, J., 300.—Smith, W. F., 298, 299, 300, 301, 302.—Webb, F. W., 300.

**TOOL, HOLLOW**, *Paper* on an improved construction of tool for turning metals at increased speed, by W. Clay, 1872, 288.—Ordinary turning at very slow speed only, 288.—Ordinary water jet very ineffectual for keeping tool cool, 288.—Description of hollow tool, 289.—Form of tool for heavy cuts, 289.—Great increase in speed of working, due to hollow tool, 289.

*Discussion.*—Clay, W., 290, 292.—Siemens, C. W., 292, 293.—Smith, W. F., 291.

**TOOMEY**, E., elected Member, 1865, 219.

**TORQUAY WATER-WORKS SCRAPER.** *See* Scraper, 1873, 216.

**TOSH**, G., elected Member, 1856, 7.

Evaporating Power of Tubes, *Paper* on the relative evaporating power of brass and iron tubes, 1857, 119.

**TOWING CANAL BOATS**, *Paper* on towing boats on canals and rivers by a fixed wire rope and clip drum, by M. Eyth, 1869, 240.—Loss of power with ordinary propellers, 240.—Early trials of towing with fixed rope, 242.—Difficulties in employing chains, 243.—Description of system of wire-rope navigation, 244.—Machinery in use on Canal de Charleroi, 245.—Machinery on river Meuse, 247.—Canal tug with portable engine, 249.—Description of engine, 249.—Wire ropes, 250.—Laying the ropes, 252.—Clip drum, 252.—Proportion of power utilised, 254.—Passage through locks, 256.—Passage

## TOWING CANAL BOATS (continued).

round curves, 257.—Crossing of tugs, 258.—Durability of ropes, 258.—Particulars of working on different canals, &c., 260.—Comparison with other modes of towing, 262.

*Discussion.*—Armstrong, Sir W. G., 273.—Bramwell, F. J., 265.—Browne, W. R., 270.—Carpmael, W., 270.—Cowper, E. A., 270.—Eyth, M., 264, 267.—Ferne, J., 268.—Hawksley, T., 270.—Head, J., 269.—Smith, W., 268.

TOWNSEND, T. C., elected Member, 1860, 53.

TOWNSEND, W., elected Member, 1863, 113.—Decease, 1871, 2.—Memoir, 18.

TRAVELLING CRANE. *See* Crane, Travelling, 1854, 96.—1868, 164.

TRAVERSING CRANE. *See* Crane, Traversing, 1864, 44.

TRESCA, H., elected Honorary Life Member, 1868, 5.

Flow of Solids, *Paper* on the "flow of solids," with the practical application in forgings, &c., 1867, 114.—Action of torsion in altering structure of iron, 147.—Difficulty of tracing changes of structure in steel, 149.—Mode of freeing Bessemer steel from air holes, 150.

TRICKETT, G., elected Member, 1857, 202.

TROW, J., elected Member, 1873, 46.

TROW, J. J., elected Member, 1865, 219.

TROWARD, C., elected Member, 1862, 47.

TRUSS, T., elected Member, 1856, 7.

TUBBING, CAST-IRON, *Paper* on cast-iron tubbing used in sinking shafts, by J. Brown, 1861, 193.—Wedging-crib to support tubbing, 194.—Mode of wedging the crib, 194.—Oak wedging-crib sometimes placed beneath usual cast-iron crib, 195.—Building up tubbing on wedging-crib, 195.—Example of very deep tubbing, 197.—Arrangement of pumps to keep shaft clear of water, 198.—Important to examine and test tubbing plates thoroughly beforehand, 199.—Strength of tubbing needed for various depths, 200.

*Discussion.*—Armstrong, Sir W. G., 202, 207.—Brown, J., 202, 203, 204.—Chrimes, R., 206.—Cochrane, A. B., 206, 207.—Cochrane, C., 202, 205, 206.—Ferne, J., 204.—Manning, J., 206.—Maudslay, H., 205.—Riley, E., 207.—Woods, H., 206.—Wright, C. T., 203, 204, 205.

TUBES, EVAPORATING POWER. *See* Evaporating Power of Tubes, 1857, 119.

TUBULAR WROUGHT-IRON CRANES. *See* Crane, Tubular, 1857, 87.

TUNNEL VENTILATING FAN. *See* Ventilating Fan, 1871, 22, 66.

TURNER, E., elected Member, 1859, 54.

TURNER, F., elected Member, 1863, 55.

TURNER, H., elected Member, 1867, 60.

TURNING TOOL. *See* Tool, 1866, 288.—1872, 288.



**TURNTABLE**, *Paper* on an improved turntable, by Samuel Lloyd, Jun., 1853, 126.—Roller turntables with fixed and live rollers, 126.—Round-edged rollers, 127.—Centre-bearing turntables, 128.—Description of improved turntable, 129.—Sliding blocks to support table when not in use, 130.

*Discussion*.—Beyer, C. F., 133.—Cowper, C., 132.—Gibbons, B., 132.—Lloyd, Sampson, 132.—Lloyd, Samuel, Jun., 131, 132, 133.—Woodhouse, H., 131, 133.

**TURNTABLE**, **WROUGHT-IRON**, *Paper* on an improved construction of wrought-iron turntable, by W. Baines, 1866, 43.—Construction of top of turntable, 43.—Section of iron ribs, 43.—Facility of increasing strength of girders wherever desirable, 44.—Roller paths, 45.—Centre pin, 45.—Hydraulic press for bending bars, 46.—Saving in weight compared with cast-iron turntables, 47.—Facility of adapting turntables to special circumstances, 48.

*Discussion*.—Baines, W., 49, 50, 52, 53.—Cowper, E. A., 52, 53.—Jones, E., 52.—Napier, R., 49, 50, 51, 53.—Neilson, W. M., 51.—Pettifor, J., 52.—Williams, R., 50, 51.

**TURTON**, J., elected Member, 1849, Apl., 32.

**TURTON**, T., elected Member, 1872, 120.

**TURTON**, T. B., elected Member, 1849, Apl., 32.

**TURTON**, W., elected Member, 1847.

**TUYERE**, *Paper* on an improved tuyere for smiths' hearths, by J. Ross, 1855, 30.—Ordinary construction of tuyere, 30.—Improved tuyere, 30.—Wrought-iron tuyere, 31.

*Discussion*.—Beyer, C. F., 32.—Fairbairn, W., 32, 33.—Ferne, J., 33.—Jones, E., 32.—Ross, J., 32.

**TUYERE**, *Paper* on an improved tuyere for smiths' hearths, by J. Fernie, 1855, 57.—First design of improved tuyere, 57.—Mode of casting tuyeres, 57.—Double hearth with tuyeres, 58.

*Discussion*.—Fairbairn, W., 58.—Ferne, J., 58.—Ramsbottom, J., 58.

**TUYERE**, *Paper* on an improved tuyere and smiths' hearth, by C. F. Beyer, 1855, 125.—Failure of ordinary tuyeres, 125.—Cast-iron tuyeres, 125.—Improved arrangement of hearth and tuyere, 126.—Hollow fire for wheel forging, 127.

*Discussion*.—Clift, J. E., 129.—Hodge, P. R., 128, 129.—McConnell, J. E., 128, 129.—Shipton, J. A., 128.—Wright, H., 128.

**TUYERE** for Blast Furnaces. *See* Blast-Furnace Tuyere, 1865, 256.

**TWEDDELL**, R. H., elected Member, 1867, 60.

**Hydraulic Machines**, *Paper* on the application of water-pressure to shop tools and mechanical engineering work, 1872, 188.—Low pressure of water not desirable, 206.—Not advisable to have two pressures in machines, because complicated, 207.—Accumulator with lever to vary pressure, 207.—Work performed by hydraulic riveter, 208.

TYLER, H. W., Capt., elected Member, 1856, 80.

TYPE-SETTING MACHINE, *Paper* on a type-composing and distributing machine, by W. H. Mitchel, 1863, 34. — Divisions of compositor's work, 34. — Two classes of type-setting machines, 36. — Descriptions of various machines, 37. — Description of improved composing machine, 38. — Adjusting speed of bands, 39. — Key action, 40. — Setting-up receiver, 41. — Distributing machine, 43. — Cutting-off action, 44. — Action of nicks in types, 46. — Difficulty in extensive employment of type-setting machines, 51. — Comparison of cost and rapidity of hand and machine setting, 52.

*Discussion.*—Beyer, C. F., 56.—Bramwell, F. J., 55.—Jaffray, J., 54.—

Mitchel, W. H., 54, 55, 56.—Siemens, C. W., 55.

TYRES, STEEL. *See* Steel Tyres, 1848, Apl., 21.—1866, 186.

## U.

UCHATIUS CAST-STEEL. *See* Steel, 1858, 146.

UPWARD, A., elected Member, 1862, 47.

USHER, G. M., elected Member, 1865, 102.—Decease, 1870, 2.—Mémorial, 17.

USHER, T., elected Member, 1872, 76.

## V.

VACUUM GAUGE, *Paper* on an improved vacuum gauge for condensing engines, by F. J. Bramwell, 1851, Jan., 27.—Ordinary long vacuum gauge, 27.—Short vacuum gauge, 27.—Improved short vacuum gauge, 28.—Stop-cock, 29.

*Discussion.*—Adams, W. A., 29.—Cowper, E. A., 29.—McConnell, J. E., 29.

VALLANCE, F. B., elected Member, 1868, 43.

VALVE, BALANCED. *See* Balanced Valve, 1857, 189.—1871, 35.

VALVE-GEAR, *Paper* on the Corliss expansion valve-gear for stationary engines, by W. Inglis, 1868, 177.—Principle of Corliss engine, 177.—Watt's disconnecting valve-gear, 180.—Early Corliss valve-gear, 180.—Improved Corliss engine, 181.—Liberating valve-rod, 183.—Dash-pot, 184.—Rate of working, 184.—Consumption of fuel, 185.

*Discussion.*—Amos, C. E., 187, 188.—Amos, J. C., 190.—Bramwell, F. J., 186.—Cowper, E. A., 186.—Douglas, R., 190.—Fairbairn, W., 193.—Hawksley, T., 187, 189, 192.—Hughes, G. D., 190.—Inglis, W., 185, 191, 193.—Neilson, W. M., 185.—Siemens, C. W., 187, 189.—Walker, B., 187.—Woods, H., 192.

**VALVE-MOTION**, Wakefield's, *Paper* on a new expansive valve-motion for steam engines, by G. M. Miller, 1855, 146.—Description of apparatus, 147.—Reversing, 148.—Results of working on locomotives, 149.

*Discussion*.—Cowper, E. A., 152.—Fairbairn, W., 151, 152, 154.—Ferne, J., 154.—Marshall, W. P., 154.—Miller, G. M., 151, 152, 153.—Ramsbottom, J., 153.

**VALVE PACKING**, *Paper* on Waddell's improved packing for the slide-valves of marine engines, by C. F. Beyer, 1856, 61.—Relieving pressure on slide-valves of large engines, 62.—Description of D valve, 62.—Defects of ordinary packing, 63.—Description of improved packing, 66.—Application to single slide-valves, 66.—Advantages of packing, 67.

*Discussion*.—Fenton, J., 69.—Fothergill, B., 67, 68, 69, 70.—Miller, J., 63.—Shelley, C. P. B., 68.—Waddell, R., 67, 68, 69.—Wymer, F. W., 70.

**VALVES for Pumps**. *See* Pump Valves, 1858, 249.

**VALVES, Safety**. *See* Safety Valve.

**VARLEY, J.**, elected Associate, 1869, 77.

**VARTRY WATER WORKS**, Dublin. *See* Water Works, Dublin, 1865, 201.

**VAVASSEUR, J.**, elected Member, 1862, 47.

**VENTILATING FAN**, BIRAM, 1869, 141.

**VENTILATING FAN**, BRUNTON, 1869, 92, 142.

**VENTILATING FAN**, GUIBAL, *Paper* on Guibal's ventilating fan employed at the Homer Hill Colliery, Cradley, by J. S. E. Swindell, 1869, 78.—Nature of coal seam and workings, 78.—Struvé's ventilator, 79.—Lemielle's ventilator, 80.—Nasmyth's ventilator, 80.—Guibal's ventilator, 81.—Closed mouth to shaft, 83.—Course of air-current, 84.—Particulars of working, 84.—Expanding outlet, 86.—Cost, 88.—Comparison with ventilating furnace, 88.

*Discussion*.—Baker, J. P., 93.—Bramwell, F. J., 94, 98.—Cowper, E. A., 95, 97.—Evans, T., 91, 98, 99.—Penn, J., 90, 100.—Swindell, J. E., 99.—Swindell, J. S. E., 92, 94, 97, 99.

*See also* 1869, 140.

**VENTILATING FAN**, NASMYTH, *Paper* on the ventilating fan at the Abercarn collieries, by E. Rogers, 1856, 251.—Arrangement of pit, 252.—Air courses, 253.—Particulars of experiments, 254.—Advantages of fan over ventilating furnace, 255.—Increased current of ventilation on occasion of explosion, 256.—Nature of "after damp," 256.—Table of fan experiments, 258.—Table illustrating a mine explosion, 259.

*Discussion*.—Cochrane, C., 264.—Hawkes, W., 262, 263.—Lloyd, Sampson, 260, 261, 262, 263, 265.—Ramsbottom, J., 265.—Rogers, E., 260, 262, 263, 264.—Shelley, C. P. B., 263.

*See also* 1869, 80.

**VENTILATING FAN**, RAMMELL, 1869, 92, 142.

VENTILATING FAN, TUNNEL, *Paper* on the mechanical ventilation of the Liverpool passenger tunnel on the London and North Western Railway, by J. Ramsbottom, 1871, 22.—Dimensions of tunnel, 22.—Difficulties of ventilation, 23.—Air shaft and fan, 23.—Provision for natural ventilation when fan not working, 24.—Description of fan, 24.—Engines, 25.—Rate of clearing smoke from tunnel, 26.—Amount of air removed in ventilating the tunnel, 26.—Vacuum at different minutes, 26.—Power expended in overcoming friction of chimney, &c., 27.—Diagrams of ventilating action, 27.—Electric signal for starting and stopping fan, 28.

*Discussion.*—Bramwell, F. J., 34.—Cochrane, W., 29, 32, 33.—Cowper, E. A., 28, 33.—Fenby, J. B., 34.—Fowler, G., 31.—Moorsom, W. M., 31, 32.—Ramsbottom, J., 29, 30, 31, 33, 34.

VENTILATING FAN, TUNNEL, *Supplementary Paper* on the mechanical ventilation of the Liverpool passenger tunnel on the London and North Western Railway, by J. Ramsbottom, 1871, 66.—Table of experiments on degrees of vacuum, 66.—Particulars of experiments, 67.—Ind. H. P. of engine when exhausting the tunnel, 68.

*Discussion.*—Alexander, A., 71.—Barry, J. W., 73.—Bramwell, F. J., 70.—Cochrane, C., 73.—Cowper, E. A., 71.—Ramsbottom, J., 68, 70, 72, 74.

VENTILATING FAN, WADDLE, 1869, 92, 142.

VENTILATING FURNACE for Collieries, 1849, July, 35.—1856, 255.—1858, 37, 63, 203.—1869, 88, 133.

VENTILATING MACHINE, LEMIELLE, *Paper* on Lemielle's ventilating machine for mines, by Samuel Lloyd, Jun., 1858, 63.—Loss of effect from use of furnace for ventilation, 63.—Description of Lemielle's ventilator, 64.—Very small loss in discharge of air, 65.—High degree of vacuum obtainable, 66.—Trial of machine, 66.

*Discussion.*—Cowper, E. A., 68, 69.—Fernie, J., 69.—Laurent, F., 67., 68, 69.—Lloyd, Samuel, 67, 68.—Maudslay, H., 67, 69.—Muntz, G. F., 68.—Smith, F., 67.

*See also* 1869, 80, 147.

VENTILATING MACHINE, STRUVÉ, 1869, 79, 146.

VENTILATION OF BUILDINGS, *Paper* on the ventilation of public buildings, by Gen. A. Morin, 1867, 61.—Principles on which ventilation should be based, 61.—Suction superior to blowing, 62.—Quantity of air per person and temperature in various buildings, 63.—Relations between volume and temperature of air and area of flue, 64.—Increasing velocity of air in passing through building, 64.—Examples of ventilation of various public buildings, 65.—Experiments on ventilation of Théâtre Lyrique in Paris, 71.

# VENTILATION OF BUILDINGS (continued).

*Discussion.*—Bramwell, F. J., 75.—Chadwick, E., 72.—Fairbairn, W., 77.—Moriu, Gen. A., 72, 75, 76, 78.—Penn, J., 72, 79.—Siemens, C. W., 75, 76.—Whitley, J., 74.

VENTILATION OF BUILDINGS, MECHANICAL, *Paper* on the mechanical ventilation and warming of St. George's Hall, Liverpool, by W. Mackenzie, 1863, 194.—Supply of air, 194.—Warming, 194.—Hot-water coils, 195.—Cooling, 196.—Moisture, 196.—Ventilation, 197.—Discharge of vitiated air, 199.—Outlet shafts, 200.—Air valves, &c., 200.

*Discussion.*—Bramwell, F. J., 202, 203.—Clay, W., 201, 208.—Ferne, J., 205, 207.—Mackenzie, W., 201, 203, 204, 207.—Newton, W. E., 204.—Plum, T. W., 203.—Smith, I., 205.

VENTILATION OF BUILDINGS, WATSON'S, *Paper* on Watson's ventilating apparatus for buildings, &c., by S. Thornton, 1857, 259.—Principle of ventilation, 259.—Description of ventilator, 260.—Experiment showing action of ventilator, 261.—Temperature of ascending current, 262.—Modifications of ventilator, 263.—Application to factories, &c., 264.—Ventilation of ships, 265.

*Discussion.*—Lloyd, Sampson, 266.—Watson, C., 266.

VENTILATION OF COLLIERY, *Paper* on the system of ventilation in the Wallsend Colliery, by D. Burn, 1849, July, 31.—Explosions of fire-damp with great loss of life, 31.—Description of workings, 32.—Quantity of air circulated in each district of mine, 32.—Summary of divisional currents, 34.—Cost of ventilating furnaces, 35.—Large constant discharge of gas, but of low illuminating power, 35.—Proposed application for lighting Newcastle, 35.—Process for increasing the illuminating power, 35.—Davy lamps used throughout workings, 36.—Rules and regulations for the colliery, 36.

*Discussion.*—Clift, J. E., 37, 38.—Gibbons, B., 38.—Slate, A., 38.

*See also* Coal Mining, 1862, 68.—Coal, South Staffordshire Thick, 1860, 91.—Colliery, Newcastle, 1858, 177.

VENTILATION OF MINES, *Paper* on the ventilation of mines, by B. Gibbons, 1851, Apl., 8.—Explosions of gas, 10.—Artificial ventilation objectionable, except as auxiliary, 11.—Ordinary system of mining in Staffordshire Thick coal, 12.—Air current liable to interruptions when upcast shaft used for winding, 13.—Air-head, spouts, &c., 14.—Improved system of mining, 15.—Air-head above top of seam, 16.—Excavating the coal, 17.—Air chimney, 19.—Advantages of improved system, 21.—Importance of draining gas from coal before it gets into workings, 23.—Objections raised against improved system, 25.—Getting whole of coal, 28.—Explosions destroying ventilation in mines worked in "panes and pillars," 29.—Shafts divided by brattices, 30.—Sinking through running



## VENTILATION OF MINES (continued).

sand, 31.—Conditions and principles for carrying out improved system of mining, 31.—Necessity for more numerous shafts than now used, 33.

*Discussion.*—Adams, W. A., 36.—Clift, J. E., 34.—Cowper, E. A., 34.—Gibbons, B., 34, 35.—Hodgkinson, E., 35.—McConnell, J. E., 34, 36.—Shipton, J. A., 34.—Slate, A., 35.

VENTILATION OF MINES, *Paper* on the various systems of ventilation of mines, by W. Cochrane, 1869, 133.—Furnace ventilation, 133.—Large furnaces in Durham coalfield, 134.—Table of duty of furnaces, 136.—Open and closed furnaces, 137.—Influence of depth of shaft, 138.—Guibal ventilator, 140.—Comparison with furnace, 141.—Other centrifugal ventilators, Biram, Waddle, Rammell, Brunton, 141, 142.—Effect of casing, expanding chimney, and adjustable shutter of Guibal fan, 143.—Large Guibal fan in Belgium, 144.—Form of casing, 144.—Curvature of vanes, 145.—Struvé's ventilator, 146.—Lemielle's ventilator, 147.

*Discussion.*—Armstrong, Sir W. G., 153.—Cochrane, W., 151, 152, 153.—Cowper, E. A., 150.—Morison, D. P., 152.—Steavenson, A. L., 149, 152.—Swindell, J. S. E., 149.

VERNON, J., elected Member, 1856, 49.—Council, 1865, 19.

Ships, Iron, *Paper* on the construction of iron ships, 1863, 115.—Deficiency of strength in upper deck of iron ship, 141.—Drilled holes for riveting not superior to punched holes, 142.

Tools, punched holes quite as accurate as drilled, 1864, 213.

VICKERS, A., elected Member, 1865, 219.

VICKERS, T. E., elected Member, 1861, 109.

Strength of Steel, *Paper* on the strength of steel containing different proportions of carbon, 1861, 158.—Long test bars show lower tensile strength than short bars, 167.

VICKERS, W., elected Member, 1848, July, 20.

## W.

WADDELL, R., Escape Valve, *Paper* on an escape water-valve, and a governor for marine steam engines, 1853, 117.

Valve Packing, material for packing, 1856, 67.—Difficulty in detecting leakage of ordinary packing, 69.—Marine-engine valves should not be quite balanced, 69.

WADDINGTON, J., elected Member, 1856, 80.

WADDINGTON, T., elected Member, 1856, 80.—Decease, 1870, 2.—Mémorial, 17.

WADDLE VENTILATING FAN, 1869, 92, 142.

WAGON COUPLING. *See* Railway Safety Wagon Coupling, 1860, 277.

WAGONS, Railway. *See* Railway Wagons.

WAINWRIGHT, W., elected Member, 1865. 219.

WAKEFIELD, J., elected Member, 1863. 58.

WAKEFIELD'S VALVE MOTION. *See* Valve Motion, 1855, 146.

WALDENSTRÖM, E. H., elected Member, 1873. 46.

WALKER, ALEXANDER, elected Member, 1872, 120.

WALKER, ALFRED, elected Member, 1870, 19.

WALKER, B., elected Member, 1867, 234.

Governor, Allen. successful for rolling mills, 1873, 56.—Ordinary throttle-valve too much friction, and liable to jam, 57.

WALKER, B. P., elected Member, 1864. 59.

WALKER, C. C., elected Member, 1855. 6.—Re-elected, 1867, 60.

Cupola, experiments on influence of size and shape of cupola on consumption of fuel, 1868, 96.—Cleveland iron very wasteful in cupolas, 98.

Observatory, Iron, *Paper* on a wrought-iron observatory for maintaining equality of internal and external temperature, 1873, 279.—Brick or stone observatories condense much moisture after long frosts, 286.—Temperature of internal air in iron observatory, mean of external in sun and in shade, 287.—Cost of iron observatory, 287.—Weight of revolving parts, 288.

Railway Chair, Bracket, experiments on breaking strain of cast-iron bars, 1873, 257.

WALKER, J. G., elected Member, 1861, 14.

WALKER, THOMAS (Birmingham). elected Member, 1854. 110.

WALKER, THOMAS (Wednesbury), Original Member, 1847.—Council, 1852, 8.

WALKER, W. H., elected Member, 1863. 246.

WALLACE, J., Jun., Dash Wheel, *Paper* on a steam dash-wheel for bleaching, 1856. 239.

WALLACE, W., elected Member, 1863, 246.

WALLER, G. A., elected Member, 1865. 20.

WALLER, W., elected Graduate, 1856. 7.

Agricultural Engines, *Paper* on the application of steam power to agricultural purposes, 1856, 80.—Steam pressure, 104.—Arrangement of tubes in boiler, 104.—Racing engines used in trials, not suitable for regular work, 106.

Barn Machinery. *Paper* on the application of steam power to agricultural purposes, 1856. 266.

Boiler Explosions, failure of boiler from unequal expansion of plates of different kinds of iron, 1866, 171.

Field Implements, *Paper* on the application of steam power to agricultural purposes, 1857, 41.

WALLIS, H., elected Member, 1868, 104.

WALLIS PRESSURE GAUGE. *See* Pressure Gauges, 1871, 281.

WALPOLE, T., elected Member, 1865, 20.

WARDEN, H. W., elected Graduate, 1867, 60.

WARDEN, T., elected Honorary Member, 1865, 102.

WARDEN, W. E., elected Member, 1864, 271.

WARDEN, W. M., elected Honorary Member, 1848.

WARDLE, C. W., elected Member, 1856, 7.

Elevator for Colliery Drainage, *Paper* on an application of Giffard's injector as an elevator for the drainage of colliery workings, 1861, 220.

WARHAM, J. R., elected Member, 1852, 191.

WARSOP, G., Aero-Steam Engine, actual saving of fuel from use of air-injection, 1870, 241.—Proportion of air to steam, 245.

WARSOP AERO-STEAM ENGINE. *See* Aero-Steam Engine, 1870, 229.

WATER AXLEBOX, Aerts'. *See* Axlebox, Water, 1860, 178.

WATER FILTER, Forster's. *See* Filter, 1854, 75.

WATER GAUGE, MAGNETIC, *Paper* on Pinel's magnetic water-gauge for steam boilers, by G. Piggott, 1860, 83.—Description of gauge; absence of friction, 83.—Fixing and adjustment, 84.—Sensitiveness of gauge, 85.—Number of gauges in use, 85.

*Discussion.*—Batho, W. F., 85, 86.—Bramwell, F. J., 87.—Cowper, E. A., 87.—May, C., 87.—Muntz, G. F., 87.—Neilson, J. B., 86.—Richardson, W., 86.—Robinson, J., 85, 86.—Siemens, C. W., 86, 87.

WATER METER, Chadwick's, *Paper* on recent improvements in water meters, by B. Fothergill, 1857, 172.—Importance of use of water meters, 172.—Prices charged for water supply, 172.—Low-pressure meters objectionable, 173.—Diaphragm meters, 174.—Piston meters, 174.—Description of Chadwick's piston meter, 175.

*Discussion.*—Chadwick, D., 178.—Forsyth, T., 177, 178.—Fothergill, B., 176, 177.—Green, 177.—Maudslay, H., 177.—Whitworth, J., 177, 178.

WATER METER, Gorman's, *Paper* on an improved water meter, by W. Gorman, 1856, 242.—Objects to be attained in meters, 242.—Description of improved rotary meter, 243.—Results of working, 244.

*Discussion.*—Fothergill, B., 246.—Gorman, W., 244, 246.—Neilson, W. M., 246.—Ramsbottom, J., 246.—Rankine, W. J. M., 244, 245.—Scott, M., 246.—Siemens, C. W., 245, 247.

WATER METER, Kennedy's, *Paper* on an improved water meter, by T. Kennedy, 1856, 151.—Want of reliable meter, 151.—Principles of various meters, 152.—Description of improved piston meter, 153.—Rolling packing, 153.—Tumbling lever, 154.—Indicating apparatus, 154.—Particulars of trials, 155.—Sizes of meters, 156.

*Discussion.*—Kennedy, T., 157, 158.—Muir, 157.—Neilson, W. M., 157.—Whitworth, J., 157, 158.

**WATER METER**, Parkinson's, *Paper* on a water meter, by W. Parkinson, 1851, Jan., 19.—Various plans of meters, 19.—Description of improved meter, 20.

*Discussion*.—Clift, J. E., 21.—McConnell, J. E., 22.

**WATER METER**, Siemens', *Paper* on an improved water meter, by C. W. Siemens, 1854, 6.—Requirements of a meter, 7.—Classification of meters, 7.—Bucket meters, 8.—Piston meters, 9.—Meters by area of flow, 9.—Description of improved meter by area of channel, 10.—Impact meters, 11.—Description of improved meter, 12.—Counting gear, 13.—Effect of second drum, 14.—Spindles, 15.—Screw-drums, 16.—Description of small spiral meter, 17.—Mode of testing, 18.

*Discussion*.—Chellingworth, T. T., 22.—Clift, J. E., 19, 20.—Cowper, E. A., 19.—Fairbairn, W., 19, 20, 23.—Hodge, P. R., 20, 22, 23.—Siemens, C. W., 18, 19, 20, 22.—Slate, A., 21, 23.—Taylor, T., 23.

**WATER METER**, Siemens', *Paper* on an improved water meter, by C. W. Siemens, 1856, 113.—Description of improved meter, 113.—Size of inlet and outlet, 114.—Results of application of meters, 116.—Waste of water, 116.—Advantages from use of meters, 117.—Sizes of meter, and number in use, 118.

*Discussion*.—Allen, J., 118.—Bell, T., 121, 122.—Chrimes, R., 122, 123.—Forsyth, T., 122.—Greaves, C., 119, 120.—Lloyd, Sampson, 118, 120, 123.—Siemens, C. W., 118, 119, 123.

**WATER METER**, Taylor's, *Paper* on an improved water meter, by B. Fothergill, 1853, 142.—Requirements of a meter, 142.—Description of Taylor's meter, 143.—Regulating valves, 144.

*Discussion*.—Cowper, C., 147.—Fairbairn, W., 146, 147.—Fothergill, B., 145, 146, 147.—Perring, J. S., 146.—Rofe, H., 146, 147.—Shipton, J. A., 147.—Thompson, J., 146, 147.

**WATER PRESSURE MACHINERY**. *See* Hydraulic Machinery, 1858, 126.—1868, 21.—1869, 208.—1872, 188.

**WATER RAISING APPARATUS**. *See* Locomotive Water Supply, 1859, 211.

**WATER SUPPLY FOR LOCOMOTIVES** whilst running. *See* Locomotive Water Supply, 1861, 43.

**WATER WORKS, DUBLIN**, *Paper* on the new Dublin Corporation Water Works for the supply of water from the river Vartry, by P. Neville, 1865, 201.—Former sources of supply, 201.—Position of river Vartry, 202.—Rainfall over drainage area, 203.—Roundwood reservoir, 203.—Filter beds, 204.—Tunnel, 205.—Course of main, 205.—Stillorgan distributing reservoirs, 206.—Screens, 207.—Cost, 207.

*Discussion*.—Gray, Sir J., 209, 211, 213, 214.—Murphy, J., 208, 212, 213.—Napier, R., 208, 211, 212, 214.—Neville, P., 208, 209, 212.—Newton, W. E., 209.

**WATER WORKS, GLASGOW**, *Paper* on the mechanical appliances of the Loch Katrine Water Works for the supply of Glasgow, by J. M. Gale, 1864, 123.—Former supply of Glasgow, 123.—General arrangement of present works, 123.—Drainage area, 124.—Very soft water, 124.—Extent of water supply, 125.—Salmon stairs, 126.—Aqueduct, 127.—Tunnel, 128.—Aqueduct bridges, 129.—Junction of wrought-iron tube and cast-iron trough, 129.—Syphon pipes, 131.—Service reservoir and straining well, 132.—Valves, 134.—Daily supply of water, 135.—Cost of works, 136.—Table of rainfall, 137.

*Discussion*.—Birckel, J. J., 144.—Bramwell, F. J., 142.—Cowper, E. A., 138, 141, 143.—Ferne, J., 139, 144.—Gale, J. M., 138, 139, 140, 141, 142, 143, 144, 145, 146.—Humphrys, E., 140.—Manning, J., 138.—Maudslay, H., 142.—Napier, R., 138, 139, 140, 145, 146.—Newton, W. E., 138, 140, 141, 144.—Rigg, A., 140, 146.—Smith, I., 140.—Snowdon, T., 140.—Swindell, J. E., 145.

**WATER WORKS, LIVERPOOL**, *Paper* on the mechanical features of the Liverpool Water Works, by T. Duncan, 1863, 167.—Area of water supply, and general arrangement, 167.—Slide-valves, 168.—Sluices and gauges on goit, 169.—Filter beds, 170.—Sand-washing apparatus, 171.—Float-valve and self-acting shut-off valves, 172.—Self-acting reflux and throttle valves, 173.—Escape valves, air cocks, &c., 175.—Mains, 176.—Portable meters for shipping-service supplies, 178.—Wells and pumping engines, 179.—Tables of particulars of pumping engines, &c., 183.

*Discussion*.—Beloe, H. C., 189.—Birckel, J. J., 192.—Clay, W., 186, 189, 192.—Cunningham, J., 187.—Duncan, T., 186, 187, 188, 189, 190, 192.—Gray, J. M. F., 191.—Kennan, J., 187.—King, W., 187.—Lloyd, S., 188.—Mackay, J., 188.—Maclaren, R., 188.—Markham, C., 187.—Marshall, P. P., 190, 191.—Ramsbottom, J., 186.—Smith, I., 189, 191.

**WATER WORKS, MANCHESTER**, *Paper* on the Manchester Water Works, by J. F. Bateman, 1866, 245.—General plan, 245.—Rainfall, 246.—Separation of clear and turbid waters, 247.—Reservoirs and aqueduct, 248.—Special valves, 250.—Air-valves and hydrants, 252.—Turbines for opening large sluices, 253.—Gauge-plates, 254.—Strainers, 255.—Gauging the water supplied to mill owners, 255.

*Discussion*.—Downing, S., 257, 258, 259.—Fairbairn, W., 257, 258, 259, 260.—Kennan, J., 259.—Maudslay, H., 259.—Whitworth, J., 260.

**WATER WORKS, Pumping Engines**. See Pumping Engines.

**WATER WORKS, Scraper for Mains**. See Scraper, 1873, 216.

**WATERHOUSE, T.**, elected Honorary Member, 1858, 266.

Compressed-Air Hammer, durability of cam and roller, 1858, 121.—Cost of hammer, 122.

**WATKIN, W. J. L.**, elected Member, 1867, 60.



WATKINS, R., elected Member, 1862, 93.

WATSON, R., elected Member, 1866, 265.

WATSON'S VENTILATING APPARATUS. *See* Ventilation of Buildings, 1857, 259.

WATT, JAMES, Monument, inauguration of, 1857, 85.

WATTEU, E., elected Member, 1866, 265.

WATTS, W. T., elected Associate, 1867, 234.

WEALLENS, W., Original Member, 1847.—Council, 1849, Jan., 9.—1858, 12.—1861, 13.—Decease, 1863, 2.—Memoir, 13.

Express Engine, *Paper* on an express engine, 1849, Apl., 8.

WEAVING MACHINERY FOR CARPETS. *See* Carpet Weaving, 1868, 195.

WEBB, F. W., elected Member, 1862, 47.—Council, 1871, 20.—1873, 24.

Boilers, Corrosion of, telescopic boiler, 1866, 72.—Grooving at lap-joints, not at butt joints, 72.—Barrels with single longitudinal joint, 73.—Pitting of boilers with brass tubes, using acid water, 73.—Injurious straining from cold feed-water, 74.

Cupola, consumption of fuel in Krigar cupola, 1868, 95.

Indicator, Richards, successful for locomotives, 1863, 267.

Locomotive Engines, water troughs for supplying engines while running, 1863, 108.

Puddling, Mechanical, saving of labour and time with Siemens regenerative puddling furnaces, 1867, 171.

Shaping Machine, *Paper* on a curvilinear shaping machine, 1866, 280.—Speed of working, 283.—Object of curved inner face to rim of wheels, 285.—Durability of well-balanced pulleys, 285.—Forging of spokes, 286.

Tool and Holder, large tool advisable for heavy cuts, to carry away heat from point of tool, 1866, 300.

WEBB, H. A., elected Member, 1862, 47.

WEBSTER, J., Pressure Gauge, temper of diaphragm plates, 1855, 135.—Durability of india-rubber joint, 136.

WEEKS, T. S., Scraper for Torquay Water Works, cost of scraping, 1873, 230.—Finding scraper when lost, 230.

WEIGHT OF LOCOMOTIVES, Distribution. *See* Locomotives, Distribution of Weight, 1864, 92.

WEIGHTS AND MEASURES. *See* Decimal Measure, 1865, 32.

WEILD, W., elected Member, 1860, 250.

Carpet Weaving, *Paper* on the machinery for weaving Brussels carpet by power, 1868, 195.—Speed of working, 207.—Number of threads in best Brussels carpets, 207.—Attendance required to each loom, 208.

Cotton-Drawing Rollers, *Paper* on the construction of drawing rollers for spinning machinery, 1863, 59.—Use of small drawing rollers, 73.—Rapidity of grooving of rollers, 74.—Mode of making the mills, 74.—Centering of rollers, 76.—Covering of rollers, 77.

WEILD, W. (continued).

Spooling Machine, *Paper* on a self-acting machine for spooling thread, 1861, 54. — Cost of machine, 67.—Adjustment for different sizes and shapes of spools, 67. — Swivelling guide for thread, 68. — Turning the spools, 69. — Stopping when winding completed, 70.

WELCH, E. J. C., elected Member, 1872, 254.

Air Engine, Heated, heating throws engine out of square, causing friction, 1873, 77. — Plumbago and soapstone mixed for lubrication, 77. — Slide-valves successful where flap-valves failed, 77.

WELL BORING. *See* Boring Wells, 1867, 174.—1869, 278.

WELLS, C., elected Member, 1862, 47.

WENHAM, F. H., Air Engine, Heated, heating of joints, great difficulty, 1873, 76.—Inferior bituminous coal is best, especially if moist, 76.—Moist air better than dry, 76.—Plumbago successful as lubrication where oil failed, 77.—No trouble from ashes getting into valves, 78.—Expanding the air in cylinder not successful, 79.—Larger sized engines more efficient, 80.—Important to prevent heating of joints, 81.—Consumption of fuel, 81.

WENHAM'S HEATED-AIR ENGINE. *See* Air Engine, Heated, 1873, 63.

WEST, F. W. S., elected Member, 1857, 202.—Decease, 1861, 2.

WEST, H. J., elected Member, 1871, 117.

WEST, W., elected Member, 1847.

WESTMACOTT, P. G. B., elected Member, 1862, 93.—Council, 1869, 19.—1871, 20.

Corn Warehousing Machinery, *Paper* on the hydraulic machinery for warehousing grain at the Liverpool docks, 1869, 208.—Barley injured in transporting by means of a screw, 223.—Power required to transport grain by screws and by travelling bands, 226. — Oblique rollers at points of throwing off, 227.

WESTON, T. A., elected Member, 1867, 60.

Friction Coupling, *Paper* on an improved friction coupling and break, and its application to hoists, windlasses, and shafting, &c., 1868, 214.—Discs for ship's windlass, 235.—Durability of wood discs, 236.

WETHERED, J., Superheated Steam, mixture of ordinary steam and superheated steam to control temperature of cylinder, 1860, 35.—Results of application, 36.

WHEATLEY, T., elected Member, 1867, 60.

WHEELS, BALANCING. *See* Balancing of Wheels, 1848, June, 2.

WHEEL MOULDING. *See* Moulding Machine, 1855, 41.—1868, 238.

WHEELS, TEETH. *See* Teeth of wheels, 1848, Apl., 4.

WHEEL, WROUGHT-IRON, *Paper* on a solid wrought-iron wheel, by H. Smith, 1849, Apl., 9.—Wheel disc-shaped, and forged solid in one piece with tyre, 9.—Greater strength and durability than ordinary wheels, 10.—Objections

## WHEEL, WROUGHT-IRON (continued).

to manufacture of ordinary wheels, 10.—Separate tyres put on disc-wheel in repairs, 11.—Process of manufacture, 11.—Soundness of make, and freedom from risk of broken tyre, 12.—Experiments on comparative resistance of air to disc-wheels and spoke-wheels, 13.—Advantage of less resistance in disc-wheel, 16.

*Discussion.*—Adams, W. A., 20.—Allan, A., 20.—Beyer, C. F., 20.—McConnell, J. E., 18.—Middleton, W., 20.—Slate, A., 20.—Smith, H., 18, 19, 20.—Stephenson, R., 18, 19, 20.—Woodhouse, H., 19.

WHEELDON, F. R., elected Member, 1856, 49.

WHIELDON, W., elected Member, 1872, 120.

WHITE, A., Corn-Mill Machinery, *Paper* on improved corn-mill machinery, 1856, 140.—Speed of stones, 142.—Amount of wheat ground per hour, 143.

WHITE, I., elected Member, 1864, 59.

WHITE, R. L., elected Associate, 1866, 104.

WHITEHEAD, P. O., elected Member, 1868, 43.

Colliery Working, Midland, endless chain for winding in Lancashire, 1870, 168.

WHITEHEAD, W., elected Honorary Member, 1862, 314.—Decease, 1871, 2.—Memoir, 19.

WHITEHOUSE, H. B., elected Member, 1856, 49.

WHITHAM, JAMES, elected Member, 1859, 54.

WHITHAM, JOSEPH, elected Member, 1859, 54.—Decease, 1867, 2.—Memoir, 16.

WHITLEY, J. (Birmingham), elected Member, 1863, 58.

WHITLEY, J. (Leeds), elected Honorary Member, 1865, 219.

Governor, Allen, slotted disc and set-screw to adjust position of spiral, 1873, 56.—Stuffing-box of governor spindle and throttle-valve spindle, 58.

WHITLEY, J. R., elected Associate, 1873, 88.

WHITTAKER, T., elected Member, 1863, 58.

WHITTEM, T. S., elected Member, 1869, 276.

WHITTLE, W., Boiler Lining, deposited mud removed by blowing off, or by opening boiler and shovelling out, 1871, 60.—Boiler may work for six months without cleaning out mud, 60.—Cost of application of lining to boilers, 62.

WHITTLE Boiler Lining. *See* Boiler Lining, 1871, 48.

WHITWELL, T., elected Member, 1866, 18.

Hot-Blast Stoves, modification with vertical transverse walls, 1870, 94.—Means of cleaning, 95.—Dimensions of stoves, 95.—Temperature of blast, 96.—Cast-iron plates to absorb heat of escaping gas, 97.—Saving in consumption of coke, 98.—Probable difficulty in cleaning Cowper's stoves, 98.—Air for combustion not all admitted at once, 105.—Cost of stoves, 106.

WHITWELL, T. (continued).

Iron Manufacture, Hæmatite, failure of high hæmatite furnaces, 1871, 137.—  
Very favourable working of furnaces at Consett Iron Works, 138.—  
Temperature of blast and of escaping gases, 138.

WHITWELL'S REGENERATIVE HOT-BLAST STOVES. *See* Hot-Blast Stoves, 1870, 94.

WHITWORTH, Sir J., elected Member, 1847.—Council, 1850, Jan., 5.—Vice-President, 1853, 7.—1854, 5.—1855, 5.—President, 1856, 6.—1857, 11.—Vice-President, 1858, 12.—1859, 13.—1860, 13.—1861, 13.—1862, 19.—President, 1866, 16.

Address as President, 1856, 125.—Malleable iron and steel, 126.—True plane, and measurement, 127.—Gradations of size in making machines, &c., 128.—Decimal weights and measures, 129.—Increasing use of machinery, 130.—Wages, 131.—Objections to taxes on special articles, 131.

Decimal Measure, *Paper* on a standard decimal measure of length for mechanical engineering work, &c., 1857, 134.—Proposed decimal scale including same sizes as old gauges, 145.—Present wire-gauges very uncertain in size, 146.—Description of Whitworth's measuring machine, 1859, 122.—Process of making duplicate of standard bar, 122.—Space of 1-2,000,000th of an inch can be perceived, 123.—Decimal wire-gauges and rules, 123.—Standard cylindrical gauges, 126.—Microscope measuring instrument for line-measures, 126.—End or contact-measure far superior to line-measure, 126.—Microscopes not suitable for workshop use, 127.—Mode of making ends of standard bars truly at right angles, 130.—Standard yard line-measure is at present the only authorised measure, 131.—Not advisable to attempt to fix universal unit by act of parliament, 131.

Guns, Proof by Measurement, *Paper* on the proof of guns by measurement, with description of the instrument employed, 1866, 105.—Best form of shot for range, 110.—Windage, 110.—Proportion of powder, 111.—Effect of air-space, 112.—Effect of increased length of shot, 112.—Platinum vent-piece, 114.

Whitworth Scholarships, vote of thanks on founding, 1868, 163.

WHYTEHEAD, W. H. K., elected Member, 1852, 41.—Decease, 1866, 2.—  
Memoir, 14.

Pump, *Paper* on a new direct-acting steam pump, 1852, 174.

WICKHAM, H. W., elected Member, 1859, 248.—Decease, 1868, 2.—Memoir, 18.

WICKHAM, L. W., elected Member, 1859, 248.

WICKSTEED, J. H., elected Graduate, 1868, 104.

WICKSTEED, T., elected Member, 1863, 15.—Decease, 1872, 2.—Memoir, 22.

WIGHAM, J. R., elected Member, 1868, 104.

WIGRAM, R., elected Member, 1868, 104.

WILD, C. J., elected Member, 1847.

WILKES, G., elected Member, 1867, 234.

WILKES, J., elected Member, 1867, 234.

WILKIESON, C. V., Col., elected Member, 1868, 20.

WILLIAMS, B., elected Member, 1854, 49.

WILLIAMS, E., elected Member, 1865, 54.

Puddling, Mechanical, very efficient stirring in revolving vessel, 1867, 163.—

Cinder fettling, 165.—Cooling of vessel between heats, 165.

WILLIAMS, Sir F. M., elected Member, 1872, 76.

WILLIAMS, R., Original Member, 1847.

Boiler, Cast-Iron, doubtful if cast iron will prove durable enough for boilers, 1871, 278.

Turntable, Wrought-Iron, great advantage of ribbed section of iron for girders, &c., 1866, 50.—Butt joints of ribbed iron even stronger than the solid, 51.

WILLIAMS, R. P., elected Member, 1859, 54.

Dredgers, mode of removing spoil in light ground by forcing through pipe, 1867, 215.

WILLIAMS, WALTER, elected Graduate, 1850, July, 43.—Member, 1869, 120.

Railway Axles, fibre of iron injured by quenching in water when hot, but restored by drawing down hot, 1850, Jan., 15.

WILLIAMS, WILLIAM, elected Member, 1858, 45.—Decease, 1860, 2.

WILLIAMS, W. L., elected Member, 1873, 88.

WILLIAMSON, A. W., elected Honorary Member, 1861, 109.

High-Pressure Steam Engine, *Paper* on a boiler, engine, and surface condenser, for very high-pressure steam with great expansion, 1861, 94.—

Necessity of surface condensers for high-pressure boilers, 106.

WILLMAN, C., elected Member, 1870, 19.

WILLS, W. R., elected Honorary Member, 1855, 97.

WILSON, A., elected Graduate, 1872, 120.

WILSON, E., elected Member, 1856, 80.—Council, 1860, 13.

WILSON, E. B., elected Member, 1847.—Re-elected, 1858, 80.

WILSON, G., elected Member, 1859, 54.

WILSON, H., elected Member, 1867, 60.

WILSON, J. (St. Helen's), Pyrometer, *Paper* on a new mode of measuring high temperatures, 1852, 53.—Durability of clay pieces, 59.

WILSON, J. (Westbromwich), elected Member, 1857, 202.

Spring, *Paper* on a new convex-plate laminated spring, 1857, 219.—Weight of spring, 224.—Amount of convexity of plates, 225.—Testing strain, 225.

WILSON, J. C., elected Member, 1863, 246.

WILSON, J. E., elected Member, 1865, 219.



WILSON, J. W., elected Member, 1852, 41.

Wood Shaping Machinery, *Paper* on improved machinery for rounding, surfacing, and shaping wood, 1857, 77.—Cost of rounding and heading machines, 81.

WILSON, R., elected Member, 1857, 202.

Balanced Valve, saving from application to winding engines, 1857, 194.—  
Very little wear when applied to locomotives, 194.

WILSON, S., elected Member, 1872, 254.

WILSON, T. S., elected Member, 1873, 46.

WILSON, W., elected Member, 1860, 250.

WILSON'S Steam Engine and Governor. *See* Steam Engine, Portable, 1853, 69.

WINBY, C. E., elected Member, 1865, 219.

WINBY, F. C., elected Member, 1867, 19.

WINBY, W. E., elected Member, 1862, 20.

WINDING ENGINE, *Paper* on a new description of winding engine, by W. Fairbairn, 1853, 137.—Progress of steam engine, 137.—Arrangement of pit, 138.—Description of engine, 139.—Balancing weight of crank, &c., 140.—Winding ropes, tubs, &c., 141.—Speed of winding, 141.

*Discussion*.—Dyer, W., 141, 142.—Fairbairn, W., 141, 142.

WINDING ENGINES, Portable. *See* Mining Engines, Portable, 1873, 167.

WINGATE, T., elected Member, 1848, July, 20.

WINN, C. W., elected Member, 1872, 254.

WINSTANLEY, R., Jun., elected Member, 1872, 120.

Coal-Cutting Machine, *Paper* on a coal-cutting machine with rotary cutter, worked by compressed air, 1872, 211.—Cutting not at bottom of seam, 219.—Releasing machine when coal falls down, 219.

WINTER, T. B., elected Member, 1859, 248.

WIRE-ROPE BRIDGE. *See* Bridge, Wire-Rope, 1870, 249.

WIRE-ROPE MANUFACTURE. *See* Rope Manufacture, 1862, 170.

WIRE-ROPE NAVIGATION. *See* Towing Canal Boats, 1869, 240.

WIRE-ROPE, STEEL, durability of, 1873, 174.

WIRE-ROPE TRAVELLING CRANE. *See* Crane, Travelling, 1868, 164.

WISE, F., elected Member, 1863, 246.—Decease, 1869, 2.—Memoir, 17.

WISE, W. L., elected Member, 1872, 254.

WITHINSHAW, J., elected Member, 1872, 120.

WITHY, E., elected Member, 1871, 117.

WOLFRAM, mode of removing from tin ore, 1873, 142, 143.

WOOD, L., elected Member, 1868, 104.

WOOD, NICHOLAS, elected Member, 1858, 80.—Council, 1859, 13.—Decease, 1866, 2.—Memoir, 15.

Colliery, Newcastle, *Paper* on the improvements and progress in the working and ventilation of coal mines in the Newcastle-on-Tyne district within

WOOD, NICHOLAS (continued).

the last fifty years, 1858, 177.—Mechanical ventilation only suitable for moderate quantities of air, 233.—Probable duration of coal, 235.

WOOD, T. J. V., elected Member, 1869, 20.

WOOD BEARINGS, *Paper* on wood bearings for screw propeller shafts, by J. Penn, 1856, 24.—Rapid wear of brass bearings, 24.—Mode of applying wood bearings, 25.—Successful application to ships, 25.—Original experiments on wood bearings, 26.—Application to thrust bearings, 28.—Table of experiments on friction of bearings, 29.

*Discussion*.—Brown, J., 32.—Fairbairn, W., 30, 32, 33, 34.—Hawkes, W., 33.—Smith, F. P., 30, 32, 33, 34.

WOOD BEARINGS, *Paper* on wood bearings as applied to the shafts of screw steam vessels, by J. Penn, 1858, 81.—Great durability of wood bearings, 81.—Wood bearings for receiving end thrust of screw shafts, 82.—Table of experiments on wood and metal bearings, 84.

*Discussion*.—Cochrane, A. B., 89, 91.—Froude, W., 87, 90.—Maudslay, H., 88, 89.—Muntz, G. F., 90, 91.—Penn, J., 85, 87, 89, 91.—Siemens, C. W., 87, 89.—Smith, I., 90.—Smith, W., 87, 88.

WOOD-SHAPING MACHINERY. *See* Shaping Machine for Wood, 1857, 77.—Copying Machinery, 1858, 237.

WOODALL, S., elected Member, 1865, 54.

WOODHEAD, J. P., elected Member, 1873, 88.

WOODHOUSE, H., elected Member, 1848.—Council, 1857, 11.

Permanent Way, greater depth of rail required, 1849, Apl., 31.—Objection if broken chairs could not be replaced without taking rail out, 31.

Railway Crossing, *Paper* on an improved construction of crossing, 1856, 35.—Cost of improved crossing, 36.

WOODHOUSE, J. T., elected Member, 1851, Jan., 8.

WOODHOUSE, W. H., elected Member, 1861, 53.—Decease, 1865, 2.—Memoir, 18.

WOODS, H., elected Member, 1858, 266.

Aero-Steam Engine, vertical multitubular boiler with very rapid evaporation, no scale deposited, 1870, 244.

Railway Bridge Piers, mode of sinking very large brick cylinder for a well, 1863, 31.

Tubbing, Cast-Iron, protection of pipes by glass enamel, 1861, 206.

WOODS, J., Original Member, 1847.

WOOLLEY, JOHN, elected Honorary Member, 1863, 114.

WOOLLEY, JOSEPH, elected Honorary Member, 1854, 5.

WORKSHOPS, LOCOMOTIVE, *Paper* on the workshops for the locomotive, carriage, and wagon departments of the Manchester Sheffield and Lincolnshire railway, by R. Peacock, 1851, Jan., 22.—Position and general plan of

## WORKSHOPS, LOCOMOTIVE (continued).

works, 22.—Engine shed, 23.—Turntable, and roof of shed, 24.—Fitting shops, 24.—Carriage shop, 25.—Coke shed, 25.

*Discussion.*—Cowper, E. A., 26.—Dockray, R. B., 26.—Gibbons, B., 26.—McConnell, J. E., 27.—Peacock, R., 25, 26.

WORSDELL, T. W., elected Member, 1864, 59.

WORSSAM, S. W., elected Member, 1860, 90.

WORTHINGTON, S. B., elected Member, 1860, 14.

FRAY, W., elected Member, 1866, 265.—Decease, 1872, 2.—Mémorial, 24.

WREN, H., elected Member, 1866, 103.

WRIGHT, B., elected Member, 1859, 14.

WRIGHT, C. T., Tubbing, Cast-Iron, wood packing blown out by gas behind tubbing, 1861, 203.—Tubbing at Shireoak Colliery, 203.—Segments broken by wedging too tight, 204.—Corrosion of pressure-pipes leading from tubbing, 205.

WRIGHT, E. A., elected Associate, 1870, 126.

WRIGHT, G. B., elected Member, 1870, 126.

WRIGHT, H., elected Member, 1848.—Council, 1855, 5.

Boiler, *Paper* on an improved steam-engine boiler, 1854, 123.

Railway Wagons, axle-guard bolts broken when shunting iron-framed wagons, 1852, 211.

WRIGHT, J. (Birmingham), elected Member, 1848.—Decease, 1860, 2.

Railway Carrying Stock, increase in size and weight of carriages, 1851, Jan., 18.

Safety Buffer, objection that last carriage if detached by collision would cause danger, 1848, Apl., 17.—Great difficulty in alteration of carriages in use, 18.

WRIGHT, J. (Stockton), elected Member, 1860, 14.

Packing for Pistons, steel rings with water-pressure acting behind them very satisfactory for water-works pumps, 1862, 325.

WRIGHT, J., Jun., elected Member, 1859, 248.

WRIGHT, J. G., Riveted Joints, experiments on strength of diagonal joint, 1872, 77.—Difference of strength of plate longitudinally or crossways of grain, 78.—Strength of diagonal-jointed boilers, 90.—No difficulty or waste in shaping plates for diagonal-jointed boilers, 90.

WRIGHT, J. R., elected Graduate, 1867, 19.

WRIGHT, J. T., elected Member, 1867, 19.

WRIGHT, O., elected Member, 1863, 246.

WRIGHT, P., elected Member, 1863, 113.

WRIGHT, T. B., Steam Cultivation, proved very successful, 1865, 82.—Only light harrowing requisite after steam ploughing, 83.

WRIGHT, W., elected Member, 1871, 117.

WRIGHTSON, T., elected Member, 1871, 262.

WRIGLEY, F., elected Member, 1859, 54.—Decease, 1863, 2.—Memoir, 13.

Friction Coupling, cost of coupling, 1858, 26.

WROUGHT-IRON LIGHTHOUSE. *See* Lighthouse, Wrought-Iron, 1861, 15.

WROUGHT-IRON PISTON. *See* Piston, 1854, 119.

WROUGHT-IRON TURNTABLE. *See* Turntable, Wrought-Iron, 1866, 43.

WROUGHT-IRON WHEEL. *See* Wheel, Wrought-Iron, 1849, Apl., 9.

WYLLIE, A., elected Member, 1865, 102.

Riveter, Portable Steam, *Paper* on a portable steam riveter, 1865, 129.

WYMER, F. W., elected Member, 1853, 45.

WYNNE, F. G., Telegraph Machinery, success of paying-out Atlantic cable due greatly to steadiness of "Great Eastern," 1867, 43.—Tarred cable easier to pay out than plain hemp-covered cable, 44.

## Y.

YARROW, T., elected Member, 1856, 80.

YATES, J., Decimal Measure, Inch and Metre, reasons for selecting metre as unit, 1865, 36.—Metre more extensively used than inch, 37.—Facility of learning metrical system, 39.

YOUNG, C. F. T., elected Member, 1873, 46.

YOUNG, J., elected Member, 1856, 49.

YULE, W., elected Member, 1861, 211.

## Z.

Z-CRANK ENGINE. *See* Marine Engine, 1856, 159.

---

BIRMINGHAM :

MARTIN BILLING, SON, AND CO., PRINTERS, LIVERY STREET.

Institution of Mechanical Engineers.

---

GENERAL INDEX

TO

PROCEEDINGS.

---

1874—1884.

---

PUBLISHED BY THE INSTITUTION,  
10 VICTORIA CHAMBERS, LONDON, S.W.



*Note.*—In the Index the Papers read at the meetings are entered under their subject heads, with details of their contents and of the discussions upon them. Papers on similar subjects are as far as possible grouped together for reference.

Under the Members' names are given any particulars of their connection with the Institution during the eleven years comprised in the Index; followed by a list of subjects with which they were associated either as authors of papers or as speakers in discussions, these subjects being so arranged that the first word indicates where fuller details may be found.

Cross references are added to the subjects of the papers and to other subjects in the discussions &c.

The references are to the Year and Page in the Proceedings,—as 1881, 14; and in each Paper the year is given only at the commencement, immediately preceding the first page reference.

# Institution of Mechanical Engineers.

---

## GENERAL INDEX

TO

## PROCEEDINGS.

---

1874-1884.

---

### A.

ABBOTT, T., elected Member, 1878, 107.

Feed-Water Heater and Filter, 1881, 546.

ABBOTT, W. S., elected Member, 1883, 309.

ABEL, Sir F. A., nominated Honorary Life Member, 1883, 54.

Steel, Hardening &c., *Memorandum* on results of preliminary experiments made with thin discs of Steel, 1881, 696.—Remarks, 1882, 147.—*Report* on further experiments bearing upon the question of the Condition in which Carbon exists in Steel, 1883, 56.—Remarks, 1883, 69, 71.

ABERAMAN COLLIERY, Aberdare Valley, Waddle ventilating fan, 1874, 235.

ABERCARN TIN-PLATE WORKS, visited at Summer meeting, Cardiff, 1884, 359, 392.

ABERNETHY, J., elected Member, 1874, 101.

Vote of Thanks to President for Address, 1881, 424.

ABOUCHOFF STEEL WORKS, 1880, 225. Experiments on tensile strength of steel, 183. *See* Steel.

ACCIDENTS, MINE, *Paper* on Special Mechanical Appliances for meeting the requirements of certain classes of Mine Accidents, by C. Hawksley and E. B. Marten, 1877, 314.—Injury and danger from accidents greatly aggravated by insufficiency of mechanical means available, 314.—Loss of valuable temporary appliances, 315.—Cases illustrating frequency of accidents that require aid of mechanical appliances, 315.—Need for protection of explorers, 317.—Specially trained divers required with suitable diving apparatus, 317.—Air-lock for compressed air, 317.—Specially arranged apparatus for mine accidents to be kept at some central

## ACCIDENTS, MINE (continued).

depôt, 317.—Requirements to be kept in view, 318.—Machinery and apparatus most desirable, 318.—Greatest rapidity and efficiency required, not durability and economy in working, 319.—Pulsometer and ejector, 319.—Forms of pumps adapted for the purpose, 320.—Water-spear pump, 320.—Special portable boilers, 321.—Air-compressors, 322.—Air-lock, 322.—Boring apparatus, 322.—Portable winding gear and engines, 322.—Means of providing the special appliances required, 323.

*Discussion.*—Tylor, J. J., Proportion of deaths from different classes of accidents in different districts, 324; permanent refuges below ground must be supplied by independent ventilation, 325; difficulty in proceeding long distances with diving apparatus at great depths, 326.—Paget, A., Institution might give assistance for promoting the object proposed, 326.—Davy, H., Instances in which special pumping appliances would have been useful, 327; working of hydraulic pumping engine under special conditions, 328; apparatus for pumping out water from flooded collieries, 329.—Riches, T. H., No advantage from hydraulic engine if used in main shaft, 329; air supply-pipe to underground refuge, undesirable without an air-lock, 330.—Williams, R. P., Admirable suggested organisation, like railway "break-down gangs," 330; diving apparatus, 331; ejection of steam to expel bad air, 332; risk attending underground refuges, 333.—Fell, J. C., Hydraulic engine not suitable for relieving accumulation of water in flooded mine in the case instanced, 333.—Cowper, E. A., Knowledge of appliances used at colliery accidents should be spread to other collieries, 333; means of supplying ventilation, 334; powerful pumping arrangement required, 334.—Tweddell, R. H., Air-lock for conveying food, and extricating men in mine accidents, 336; organisation of plans for relief should be carried out by miners themselves, 336.—Robinson, J., Application of ejector for lifting water out of a flooded mine, and also for extracting foul air, 336.—Cowper, E. A., Efficient air-ejecting arrangement, 337.—Davey, H., Arrangement of hydraulic pumping engines, 337; weight of water-spear pump, 338.—Riches, T. H., Influx of water controlled by dam, 339.—Head, J., Means of obtaining the required machines, 339.—Richardson, W., Water-spear pump well adapted for emergencies, 340; fluid-compressed steel suitable for making very light pipes for great depths, 340.—Sturgeon, J., Means of protection for explorers after a mine accident, 341.—Seddon, J. F., 342.—Hawksley, C., Divers might with special appliances be enabled to proceed to great distances, 343; underground refuges would be very good if properly carried out, 343; length of air-lock, 343; desired organisation should be carried out voluntarily by colliery owners rather than by legislative action, 343; steam jets for ventilating found to work very well, 343; desirable that Institution should

## ACCIDENTS, MINE (continued).

recommend to mine-owners forms of apparatus best calculated to deal with mine accidents, 344; machinery used would have to be specially made for the purpose in view, 345; apparatus for protection of explorers should be kept at every pit, 346.—Hawksley, T., Number of cases connected with sinking and mining operations where special apparatus is wanted for urgent but temporary purposes, 347.

ACCOUNTS, Abstract of receipts and expenditure, 1874, 15.—1875, 18.—1876, 16.—1877, 15.—1878, 24.—1879, 28.—1880, 16-17.—1881, 16-17.—1882, 22.—1883, 42-45.—1884, 10-13.

ACCUMULATOR, Intensifying, 1874, 168.—Steam accumulator for hydraulic machines, 1874, 34, 50.

ACHARD, A., Power Transmission, *Paper* on the various modes of Transmitting Power to a distance, 1881, 57.—Remarks, 100.

ADAM, F., elected Graduate, 1884, 199.

ADAMS, H., elected Member, 1876, 57.

ADAMS, T., elected Member, 1875, 314.—Decease, 1883, 36.—Memoir, 1883, 1.

Condenser, McCarter, 1876, 314.

Dynamometers, 1876, 238.

Puddling, Mechanical, 1876, 284.

Steam-ship "City of Rome," 1880, 348.

Steel Compression by Steam, 1880, 407, 408.

Valves, Safety, 1877, 190.

ADAMS, W., elected Member, 1879, 155.

ADAMS, W. A., Rules, 1877, 28.

ADAMS, W. G., Electric Lighting, 1879, 256.

ADAMS, W. J., elected Member, 1881, 408.

ADAMSON, D., elected Member of Council, 1876, 26.—1880, 24.—1883, 53.

Armour, Construction of, 1879, 76.

Boiler and Engine, High-Pressure, 1877, 133.

Boiler, Lancashire, 1876, 89.

Compressed-Air Engines for Tramways, 1881, 670.

Council, Annual Report, 1884, 20.

Cultivation by Horses, 1880, 549.

Drilling Machines, 1878, 384.

Engines, Winding, Direct-acting, 1875, 239.

Harvesting Machinery, 1881, 52.

High-Pressure Vessels, 1878, 280, 281.

Hydraulic Machinery, Workshop, 1874, 176.

Howe, career of late W. Howe, 1880, 23.

Locomotive, Brown's Tramway, 1880, 72.

Locomotive, Francq's Fireless, for Tramways, 1879, 631.

## ADAMSON, D. (continued).

- Marine Engine, 1881, 501.
- Mines, Furness Iron Mines, 1880, 374.
- Plate Rolling Machinery, 1880, 95, 97.
- Research, Mechanical, 1879, 48.
- Riveting, Hydraulic, 1874, 176.
- Rules, 1878, 35, 40.—1880, 34.
- Safety Lamps, 1879, 229.
- Ships, Iron and Steel for, 1881, 571.
- Steam-ship "City of Rome," 1880, 352.
- Steel, Fluid-Compressed, and Guns, 1875, 297.
- Steel Boiler Experiments, 1878, 248, 254, 264.
- Steel Plant, Bessemer, 1881, 637.
- Testing Machine, Single-Lever, 1882, 393.
- Tuyere, Open Spray, 1876, 362, 365.
- Ventilator, Roots' Mine, 1877, 107.

ADAMSON'S BOILER-SHELL DRILLING MACHINE, 1878, 570, 584.

ADAMSON'S ENGINEERING WORKS, Hyde, 1875, 307.

ADCOCK, F. L., elected Member, 1878, 293.

## ADDRESSES OF PRESIDENTS:—

Bell, I. Lowthian, F.R.S., at Cardiff meeting, 1884, 202.—Reasons for selecting Iron as subject of address, 202.—Progress in machine construction, 203.—Early iron workers, 203.—Primitive modes of manufacture still in use, 204.—Efficiency of Bessemer process compared with puddling, 205.—Defects in manufactured malleable iron, 206.—Carbon in steel and in iron, 206.—Red-shortness due to presence of oxygen, 207.—Comparison of puddling and Bessemer processes, 208.—Delay in substituting steel rails for iron, 208.—Shipbuilding in wood, iron, and steel, 209.—Alloying iron with other metals, 210.—Question of more economical production of iron, 211.—Direct process, 211.—Economy of present smelting operations, 212.—Relative position of British and Continental iron-trade, 213.—German duty on iron, 214.—Effect of basic process on German steel-rail manufacture, 215.—Royalties in Great Britain and on the Continent, 215.—Comparative work and wages of British and Continental ironworkers, 216.—Prices of labour, 217.—Shipbuilding in Norway with English iron, 218.—Daily wages in Durham plate-mill, 219.—Sliding-scale found satisfactory for regulation of wages, 220.—Mechanical engineering, 221.—Apportionment of coal-consumption, 222.

Bird, R., Mayor of Cardiff, Vote of thanks to President for Address, 223.—Colquhoun, J., Seconds vote of thanks, 224.—Head, J., Supports vote, 224.—Carbutt, E. H., Technical education, 224.—Bell, I. L., Reply to vote of thanks, 226.



## ADDRESSES OF PRESIDENTS (continued).

Bramwell, F. J., F.R.S., at Cardiff meeting, 1874, 103.—Mechanical engineering, range of subjects, 104.—Water and gas supply, 105.—Steam printing press, 106.—Railway locomotion and steam navigation, 107.—Mining and iron making, 108.—Means of advancing the profession of mechanical engineering, 109.—Preservation of coal, 110.—Utilising other natural sources of power, 111.—Importance of economising coal, 112.—Substitution of mechanical force for manual labour, 113.—Further improvements to be desired, 114.—Change in special character of mechanical engineering, 116.

Cowper, E. A., at Annual General meeting, 1880, 28.—Success of removal of Institution to London, 28.—Position of England in respect to advancement of manufactures, 29.—Need of co-operation between manufacturers and engineers, 30.—Advantages of Institution for this purpose, 31.

Cowper, E. A., at Barrow meeting, 1880, 312.—Depression in trade, and means of promoting manufactures, 312.—Technical education, 313.—Advantages from greater enterprise in engineering and manufactures, 313.—Bessemer manufacture, 314.—Gradual advance of inventions and improvements, 314–317.—Most recent improvements, 317.—Want of further special machines, 319.—Advantage of interchanging ideas, 320.

Williams, E., Iron and steel makers at home not behind foreigners, 320; Bessemer process and rolled girders taken up very early at Dowlais, 321; aid wanted from mechanical engineers, 321.—Robinson, J., Why was manufacture of girders abandoned at Dowlais, 322; address is a stimulus to further progress, 322.—Menelaus, W., No demand for rolled girders when made at Dowlais, 322; early adoption of Bessemer process at Dowlais, 323.

Cowper, E. A., at Newcastle meeting, 1881, 413.—Formation of Institution, with George Stephenson as first President, 413.—Low prices, and effect of foreign wars, 414.—Damaging effects of excessive protective duties, 415.—Better and cheaper manufacture needed, 416.—Recent improvements in steam shipping, 416.—Stationary and locomotive engines, 417.—Automatic continuous brakes, and railway signalling, 418.—American river and harbour improvements, 418.—Lighthouse illumination and electric lighting, 419.—Steel making, and steel sleepers, 419.—Cast-iron street pavement, 420.—Manufacture of tin-plates, casks, watches, 420.—Excavating machinery, 420.—Manufacturing chemistry and glass making, 421.—Practical application of discoveries, 422.—Honours conferred on engineering profession, 423.

Hawksley, Thomas, at Bristol meeting, 1877, 167.—Especially indebted to the gentlemen concerned for the distinguished manner in which they had received the Members at Bristol Meeting, 167.—Altered position of the Institution and its future prospects, 168.—Changes connected with the

## ADDRESSES OF PRESIDENTS (continued).

removal of the Institution to London, 169.—Benefits of the Institution to mechanical engineers, 170.—Recent commercial depression and inventive inactivity, 170.—War an inevitable calamity to be provided against, 170.—Necessity for securing the paths of ocean for import of national food, 171.—Great annual loss of foreign trade from labour being too dear, 172.—False notions of workmen on international political economy, 173.—Cost of all commodities, labour included, must be closely assimilated to cost on Continent and in America, 174.

Robinson, John, at Paris Meeting, 1878, 295.—Various branches of engineering, 295.—Over-production is not yet in reality possible, 296.—Reasons for encouraging engineers to pursue their efforts in each branch, 297.—Great aim in any engineering labour is to produce the best results within reach, 298.—Constitution of Institution, 298.—Offices of Institution, 298.—Thanks due to friends who have given facilities to members, 299.—Ditto to writers of papers, 299.—Ditto to Honorary Local Secretary, 300.

Anderson, J., Vote of thanks for President's address, 300.

Robinson, John, at Glasgow meeting, 1879, 399.—On cheap internal transport considered as a necessity for the prosperity of a country, 399.—Roadway and hauling power, 402.—Collateral advantages of cheapening transport, 403.—Thanks to Local Committee, &c., 404.

Rowan, D., Cheapening of transport always calls forth a demand, 404; vote of thanks for President's address, 405.

Westmacott, Percy G. B., at Leeds meeting, 1882, 259.—Extension and cheapening of transport by land and by water, 260.—Evil of waste, especially smoke, 261.—No useful invention is ever wasted, 261:—illustration from lighting, 261:—ditto from land transport, 262.—Steam trains of coal-barges on Aire and Calder Canal, 263.—Hydraulic ship-hoists for discharging cargoes, 263.—Quicker and cheaper discharging is important both for steamers and for docks, 264.—Ditto for goods-sheds and warehouses, 265.—Precautions for protection of trade against war, 265.

Westmacott, Percy G. B., at Belgian meeting, 1883, 317.—Development of Belgian industries, 317.—Engineering progress, 318.—Relation of engineering to other sciences, 319.—Relation of speed to quality of work in engineering, 320.—Speed in ships of war, 320; ditto in torpedo boats &c., 321; ditto on railways, 322.—Substitution of petroleum refuse for coal in locomotives, 323.—Speed in tunnelling, 324.—Speed in spinning machinery, 324.—Progress in modern artillery, 325; ditto in facilities for water traffic, 327.—Principle of high speed, 327.—Progress in war materials, 328.

ADMIRALTY Treatment of marine boilers, 1884, 351. *See* Boiler Corrosion.

AGRICULTURAL MACHINERY. *See* Cultivation by Horses, 1880, 529.—Harvesting Machinery, 1881, 34.—Thrashing Machines, 1881, 369.—Sowing of Seed, 1882, 231.

AIR-COMPRESSING ENGINES; Fowler's engine, 1874, 205; Jordan's pump, 1874, 88; high-speed air-compressor, 1884, 249, 357. *See* Compressed Air. *See* Rock-Drilling Machinery.

AIR, Compressed Air upon tramways, 1881, 649. *See* Compressed-Air Engines for Tramways. *See* Tramways, Mechanical Traction.

AIR, Cooling &c., 1881, 105. *See* Cold Air.

ALDRED's permanent way for Tramways, 1880, 198. *See* Tramways, Permanent Way.

ALEXANDER, E. D., elected Graduate, 1881, 164.

ALEXANDRA DOCK, Newport, visited at Summer meeting, Cardiff, 1884, 359, 392-394.

ALLAM, E. C., elected Member, 1883, 309.

ALLAN'S BOILER-SHELL DRILLING MACHINE, 1878, 570.

ALLAN, A., Gauge, Standard, for High Pressures, 1880, 470, 472.

ALLAN, G., elected Member, 1875, 65.

Compressed-Air Engines for Tramways, 1881, 665.

Ventilator, Roots' Mine, 1877, 111.

ALLEN, A. E., elected Member, 1884, 198.

ALLEN, F., elected Graduate, 1874, 27.

ALLEN, P. R., elected Member, 1881, 408.

ALLEN, S. W., elected Member, 1884, 198.

ALLEN, W. E., elected Associate, 1880, 186.

ALLEN, W. M., elected Member, 1882, 475.

ALLENHEADS LEAD MINES, Northumberland, power transmission by water pressure, 1874, 71.

ALLEY, S., elected Member, 1877, 71.

Locomotive, Brown's Tramway, 1880, 71.

Traction Engines in India, 1879, 528.

Water-Power Engines, 1879, 488.

Water Pressure, *Paper* on the maintenance of Constant Pressure in water service pipes, 1879, 423.—Remarks, 441.

ALLEYNE, R. H. N., elected Member, 1884, 408.

ALLGOOD, R. L., elected Graduate, 1882, 16.

ALLIANCE MACHINE for electric lighting, 1878, 530. *See* Electric Lighting.

ALLIOTT, J. B., Injector, Automatic, 1884, 182.

ALLPORT, C. J., elected Member, 1876, 347.

ALMOND, H. J., elected Member, 1884, 408.

AMALGAMATION OF SILVER ORES, 1884, 257. *See* Silver Ore Amalgamation.

- AMOS, C. E., elected Member of Council, 1875, 34.—Decease, 1883, 36.—Memoir, 1.  
 Boiler, Lancashire, 1876, 121.  
 Paper Mill, Ogi, Japan, 1876, 156, 158, 160.  
 Pump, Helical, 1874, 293.  
 Water Supply from Chalk, 1876, 171.
- ANDERSON, E. W., elected Graduate, 1880, 186.
- ANDERSON, JAMES, elected Member, 1880, 185.
- ANDERSON, JOHN, elected Member of Council, 1876, 26.—1878, 29.  
 Address of President, 1878, 300.  
 Hydraulic Machinery, Toulon, 1878, 382.  
 Wood-Working Machinery, 1875, 258, 262.
- ANDERSON, J. L., elected Member, 1881, 624.
- ANDERSON, S., elected Member, 1884, 408.
- ANDERSON, WILLIAM (London), elected Member of Council, 1879, 36.—1882, 32.  
 Boiler Feeder, Fromentin Automatic, 1882, 490.  
 Centrifugal Separator, 1882, 524.  
 Cutting of Metals, 1883, 255.  
 Diving Appliances, 1882, 201.  
 Dredger, Bazin, 1882, 117.  
 Engine Recorder, 1884, 162.  
 Friction Experiments, 1883, 653.  
 Injector, Automatic, 1884, 182.  
 Paper Mill, *Paper* on the Ogi Paper Mill, Japan, 1876, 127.—Remarks, 155, 161.  
 Power Transmission by Ropes, 1874, 67.  
 Screw Propellers, 1879, 602, 606.  
 Sowing Seed, Machinery for, 1882, 247.  
 Steel, Chernoff's Papers, *Translation* of D. Chernoff's paper (1878) on the structure of Cast-Steel ingots, 1880, 152.  
*Paper*, Remarks on D. Chernoff's papers on Steel, 1880, 225.—Remarks, 232, 240, 243.  
*Translation* of D. Chernoff's paper (1868) on the manufacture of Steel, and the mode of working it, 1880, 286.  
 Steel, Hardening &c., *First Report* on the Hardening, Tempering, and Annealing of Steel, 1881, 681.—Remarks, 1882, 37, 146.  
 Water Meters, 1882, 66.
- ANDERSON, WILLIAM (York), elected Graduate, 1882, 146.
- ANGAS, W. M., elected Graduate, 1878, 558.
- ANGLEUR STEEL WORKS, 1883, 513, 537.
- ANGUS, J., Welcome to Members at Newcastle Meeting, 1881, 407.
- ANGUS, R. N., decease, 1876, 2.—Memoir, 17.
- ANNEALING of Steel Boiler Plates, 1878, 227.

ANNUAL GENERAL MEETING, 1874, 1.—1875, 1.—1876, 1.—1877, 1.—1878, 19.—1879, 21.—1880, 9.—1881, 9.—1882, 15.—1883, 33.—1884, 1.

ANNUAL REPORT OF COUNCIL, 1874, 1.—1875, 1.—1876, 1.—1877, 1.—1878, 19.—1879, 21.—1880, 10.—1881, 10.—1882, 16.—1883, 35.—1884, 2. *See* Council, Annual Report.

ANTI-BREAKAGE CRANE. *See* Docks, Cardiff.

ANTWERP DOCKS AND HARBOUR WORKS, 1883, 494, 516, 557. *See* Harbour Works.

ANTWERP, Meeting in, 1883, 313. *See* Belgian Meeting.

ANTWERP, Notes on the Trade of Antwerp, by G. A. Royers, 1883, 557.—Rise and progress, 557.—Docks, 557.—Railway stations, 559.—Diamond works, 561.—Other trades, 563.

APPLEBY, C., JUN., elected Graduate, 1878, 294.

APPLEBY, C. J., Dredger, Vertical-action, 1879, 554.

Rock-Drill, Diamond, 1875, 123.

APPLEBY, P. V., elected Graduate, 1883, 310.

ARAMBURU Y SILVA, F., elected Member, 1874, 101.

ARCHBOLD, J. G., elected Member, 1881, 163.

ARCHER, D., elected Member, 1874, 27.

ARENS, H., elected Member, 1883, 593.

ARMER, J., elected Member, 1882, 254.

ARMITT, H., Water Meters, 1882, 98.

ARMOUR, *Paper* on the construction of Armour to resist shot and shell, by C. O. Browne, 1879, 52.—Two systems for destruction of armour, 52.—Wrought-iron plates chiefly in use, 53.—Action of projectiles on armour plate, 54.—Equation for calculating penetration of shot, 54.—Action of various projectiles on wrought-iron plate, 55.—Solid and laminated plates, 56.—Experiments with 38-ton gun, 57.—Ditto with 80-ton gun, 58.—Peculiar features in the trials, 58.—Effect of strong common shell against thin plate, 59.—Important to know what thickness of plate would cause a shell to explode before reaching the backing, 60.—Chilled iron plates, 60.—Steel plates, 61.—Experiments at Spezia, 61.—Compound plates, 63.—Experiments on the "Nettle" with four special plates, 63.—Problem to find a harmless form for the absorption of the shock, 67.—Shot capped with wrought iron penetrated where chilled iron had failed, 67.—Masses of steel covered by iron would prove the best armour, 68.—Resisting power of the various classes of armour-clad ships, 68

*Discussion.*—Browne, C. O., Description of the shot used at Spezia, 69; recent experiments on forms of shot, and on coal as a protection to unarmoured vessels, 69.—Siemens, C. W., Compound armour plating would not answer well, 71; projectile should be tenacious, plate yielding, 72; sandwich armour recommended, 72.—Robinson, J., Whitworth plate, being cast under pressure, very expensive, 73.—Browne, C. O., Process



## ARMOUR (continued).

recommended for making Whitworth plate, 73.—Hulse, W. W., What experiments on sandwich plates struck at an angle by flat-headed projectiles, 73.—Colomb, P., Difference between iron and steel in direction of the work done, 74; decks &c. of ironclads liable to be set on fire, 74; in battle, ships cannot always be kept with bow to enemy, 74.—Galton, D., Flexible backing found to prevent penetration, 74; shot might penetrate further if provided with a ductile point, 75.—Williams, R. P., Effect of wrought-iron tip was against author's suggestion of having wrought-iron front plates, 75.—Paget, A., Increased depth of armour is of greater importance than nature of surface, 75; cheap ductile armour is what is wanted, 76; action of wrought-iron cap might be due to its acting as a lubricant, 76.—Adamson, D., Composition not given of the material upon which the shot operated, 76; cinder in wrought-iron plate tends to stop starring, 77; mild cast steel the best material, 77.—Hulse, W. W., Flat end might facilitate punching power of shot, 77.—Browne, C. O., Effect of impact on the wrought iron of a capped shot, 78; advantage of sandwich plates depends upon how far a ship could be constructed that would bend without injury, 78; behaviour of flat-headed and ogival-headed shot when fired obliquely, 78; objection to steel armour is its stripping off, 79; little chance of a vessel's catching fire from being struck on deck, 80; advantage of having a front plate of wrought iron, 81; remarkable jumping-up of shot in some cases, 81; wrought-iron cap on shot might be fused, but could not cause lubrication, 82.—Paget, A., Did not mean that the wrought-iron cap on the shot was fused, 82.—Browne, C. O., Wrought iron, whether on the shot or on the target, helps to keep the chilled point together, 82; description of metal used in the "Nettle" experiment, 83.—Robinson, J., Mr. Paget's meaning as to lubrication referred to flow of solids, 83.

ARMSTRONG, A., elected Member, 1879, 37.

ARMSTRONG, G. F., elected Member, 1882, 254.

ARMSTRONG, JOSEPH, SEN., elected Member of Council, 1874, 26.—1876, 26.—  
Decease, 1878, 21.—Memoir, 9.

Gauge, Railway, 1875, 80, 84.

ARMSTRONG, JOSEPH, JUN., elected Graduate, 1878, 558.

ARMSTRONG'S, SIR W., Hydraulic Machinery. *See* Docks, Cardiff.

ARMSTRONG, W., JUN., elected Member, 1876, 27.

ARROL, T. A., elected Member, 1879, 397.

ARTEAGA, A. DE, elected Graduate, 1879, 156.

ASHBURY, T., South-Wales Mineral Wagons, 1884, 431.

ASHCROFT COMBINED STEAM AND HYDRAULIC PACKING PRESS for cotton, 1877, 372.

ASHWELL, F., elected Member, 1884, 198.

ASKAM BLAST FURNACES, 1880, 486.

ASPINALL, J. A. F., elected Member, 1881, 9.

Locomotives, Fuel Consumption, 1884, 115.

ASTBURY, J., elected Member, 1877, 165.

ATELIERS DE LA MEUSE ENGINE WORKS, Belgium, 1883, 513, 534.

ATKINSON, E., elected Member, 1875, 314.

ATMOSPHERIC GAS ENGINE, 1875, 191. *See* Gas Engine, Atmospheric.

AUTOMATIC ACTION in Brakes, 1880, 100.—1882, 500. *See* Brakes.

AUTOMATIC BOILER FEEDER, Fromentin, 1882, 479. *See* Boiler Feeder.

AUTOMATIC EXPANSION, VARIABLE, 1877, 276. *See* Expansion, Variable Automatic.

AUTOMATIC EXPANSION GEAR, 1882, 408. *See* Expansion Gear.

AUTOMATIC INJECTOR, 1884, 167. *See* Injector.

AUTOMATIC SCREW-BRAKE, 1882, 500. *See* Brake.

AUTUMN MEETING, London, 1874, 253.—Manchester, 1875, 313.—1876, 347.—

1877, 299.—1878, 557.—1879, 583.—1880, 489.—1881, 623.—1882, 475.—

Birmingham, 1883, 593.—Nottingham, 1884, 407.

AVELING, T., decease, 1883, 36.—Memoir, 7.

Dynamometers, 1876, 235.

Iron and Steel for Boilers, 1879, 315.

AVELING, T. L., elected Member, 1882, 254.

AVIERO Lead-mining district, Portugal, power transmission by ropes, 1874, 65.

AVONMOUTH DOCKS, 1877, 297.

AXLEBOX, RADIAL, *Paper* on improved Radial Axleboxes and Guides, by H. W.

Widmark, 1877, 304.—Advantage over previous radial axleboxes, 304.—

Description of construction, 304.—Action of axlebox, 305.

*Discussion.*—Widmark, H. W., Arrangement for very narrow-gauge

engines, 306.—Webb, F. W., Early adoption of radial axleboxes on London

and North Western Railway, 306; present plan of long girder axlebox,

307; lateral oscillation overcome, 308; weight of long axlebox, 309.—

Williams, R. P., Objection of lateral oscillation on straight road, 309.—

Widmark, H. W., Oscillation controlled by inclined planes, 309.—

Robinson, J., Bogies should be got rid of, and every effort made to

produce radiality in the axles, 310; india-rubber side-springs for checking

lateral motion involve more weight than double inclined planes, 311.—

Cowper, E. A., India-rubber side-springs free from the retarding friction

of inclines, 311; unequal distribution of pressure liable to cause bearings

to seize, 312.—Webb, F. W., Difficulty in use of bogies with double

inclined planes, 312.—Widmark, H. W., Axlebox so long that wear of

brass will not be affected by sliding of pressure towards end of journal,

313.—Hawksley, T., Condition of friction in the case of a tottering body,

313.

AYTON, F., elected Member, 1874, 101.

## B.

BACHE, A., elected Secretary, 1884, 78.

BAGOT, A. C., elected Graduate, 1879, 38.

Electricity for Coal Mining, *Paper* on the Application of Electricity to the Working of Coal Mines, 1883, 421.—Remarks, 436.

Safety Lamps, *Paper* on the Construction and Comparative Merits of the Safety Lamps generally in use, 1879, 219.—Remarks, 232.

BAGSHAW, J. J., decease, 1876, 2.—Memoir, 17.

BAGSHAW, W., elected Associate, 1880, 10.

BAILLIE, R., elected Member, 1880, 185.

BAIN, W. N., elected Member, 1880, 185.

BAINBRIDGE, E., Compressed-Air Machinery, 1874, 227.

Petroleum Fuel in Locomotives, 1884, 310.

BAKER, S., decease, 1882, 17.—Memoir, 1.

BAKERY, Steam, at Cardiff, 1884, 367.

BAKEWELL, H. J., elected Member, 1875, 314.

Boiler Corrosion, Marine, 1884, 351.

BALANCE TIPS for discharging Coal Wagons, 1874, 125, 129. *See* Docks, Cardiff.

BALDWIN, T., elected Member, 1879, 37.

BALE, M. P., elected Member, 1877, 77.

Expansion Gear, Automatic, 1882, 434.

Harvesting Machinery, 1881, 54.

Stone-Dressing Machinery, 1881, 142.

BALL, C., Dredger, Bazin, 1882, 109, 113, 114.

BALL DREDGER, 1882, 109. *See* Dredger.

BALLAST DISCHARGE from ships, 1874, 137, 143.

BALMOKAND, Lala, elected Member, 1884, 408.

BAMLETT, A. C., Hammers, Power Hammers with Movable Fulcrum, 1882, 210.

BANDERALI, D., elected Member, 1879, 155.

Brakes, Automatic Action, 1880, 134.

Brakes, Effect of, upon railway trains, 1879, 198, 199.

Locomotives, Fuel Consumption, 1884, 116.

BANDERALI, Lartigue, and Delebecque's railway brake apparatus, 1878, 554.

BARBER, J., elected Member, 1882, 15.

BARCLAY, A., Brakes, Continuous, for railway trains, 1878, 85.

BARCROFT, H., elected Associate, 1881, 10.

BARKER's permanent way for Tramways, 1880, 197, 203, 209, 216. *See* Tramways, Permanent Way.

BARLOW, E., elected Member, 1884, 79.

- BARLOW, H. B., elected Member, 1882, 254.
- BARLOW, W. H., elected Member, 1875, 189.
- BARNETT, J. D., elected Member, 1881, 9.
- BARR, A., elected Member, 1884, 408.
- BARR, J., elected Member, 1878, 107.
- BARRAS, H. H., elected Member, 1883, 309.
- BARRATT, S., elected Member, 1879, 37.
- BARRETT, J. J., elected Member, 1882, 254.
- BARROW, J., Wood-Working Machinery, 1875, 261.
- BARROW-IN-FURNESS, rise and progress, 1880, 324, 377.
- BARROW DOCKS and Railway Approaches, 1880, 324.—Visited at Barrow meeting, 1880, 478. *See* Docks, Barrow-in-Furness.
- BARROW MEETING, Invitation, 1880, 36.—Meeting, 309.—Reception, 309.—Votes of thanks, 476.—Works visited and Excursions, 478.—Dinner, 483.
- BARROW SHIPBUILDING WORKS, visited at Barrow Meeting, 1880, 478-480.
- BARRY, J. W., Gauge, Railway, 1875, 84.
- BARSTOW, T. H., elected Graduate, 1882, 16.
- BARTLETT, J. H., elected Member, 1883, 179.
- BARTON AND WEST'S PISTON WATER METER, 1879, 444. *See* Water Meter.
- BARTON AND WEST'S WATER PRESSURE REDUCER, 1879, 434. *See* Water Pressure.
- BARTON, C. C., Water Meter, Barton, 1879, 454.
- Water Pressure Regulators, 1879, 443.
- BASCOUP COLLIERY, 1883, 518, 579. *See* Mariemont and Bascoup Collieries.
- BASTIN, E. P., elected Member, 1883, 309.
- BATEMAN, J. F., Injector Hydrants, 1879, 379, 384.
- BATH, FLOATING SWIMMING, *Paper* on the Floating Swimming Bath at Charing Cross, with the means adopted for the filtration of the water, by E. Perrett, 1875, 134.—Experiments on filtration, 134.—Means of cleansing bag filters, 136.—Site of floating swimming bath, 137.—Construction, 138.—Mooring, 140.—Supply of water, 141.—Pumping machinery, 143.—Apparatus for warming the water, 143.—Superstructure, 144.—Filtration and filter-cleansing apparatus, 145.
- Discussion.*—Perrett, E., Rate of filtration with blow-through bag-filter, 148.—Cowper, E. A., Warming water with exhaust steam, 148; filtering through bags satisfactory for bathing purposes, 149; ballast, 149; floating bath much lower rent than a building on land, 150.—Woods, H., Description of sponge filter, 150.—Homersham, S. C., Sponge filters answer well for rough process of filtering, 151.—Woods, H., Sponge filters as used at Burton, 152.—Thornycroft, J. I., Partial purification of water by settlement, 152.—Easton, E., Bag filters successful for separating finely divided particles in water, 153.—Hawksley, C., Bag filters applicable for filtration of sewage sludge, 154.—Hawksley, T., Real action of filtration

## BATH, FLOATING SWIMMING (continued).

by attraction of particles, 154.—Perrett, E., Rate of renewing the water, 155; ballast not required, 156; purification by settlement impracticable in this case, 157; cleansing of filters, 157; trials of bag filters and centrifugal filters for sugar manufacture, 158.—Bramwell, F. J., Floating bath more economical than one on land, 160; bag filters in small space not so good as if freely extended, 160; disc cloth filters for sugar making 161.

BAUERMAN, H., Coke Manufacture, 1883, 294.

BAWDEN, W., elected Member, 1881, 624.

BAZIN DREDGER, 1882, 100. *See* Dredger.

BEALE, W. P., elected Member, 1877, 299.

BEAMS, Experiments to ascertain the Strength of Cast-Iron Beams for Beam-engines, by Messrs. Easton and Anderson, 1882, 531.—Particulars of specimens tested, 531.—Results of testing, 532.—Tabulated statement of results, 533.—Remarks by B. B. Stoney, 533.

BEATTIE, A. L., elected Member, 1881, 163.

BEATTIE, F., elected Member, 1882, 15.

BEAUMONT, Major, Rock-Drill, *Paper* on Rock Boring by the Diamond Drill, 1875, 92.—Remarks, 108, 113, 114.

BEAUMONT, W. W., elected Member, 1880, 489.

Riveted Joints, 1881, 278.

Steel, Chernoff's papers, 1880, 238.

Thrashing Machines, *Paper* on Thrashing Machines, 1881, 369.—Remarks, 396, 403, 405.

BECKWITH, J. H., elected Member, 1875, 65.

BEDSON, J. P., elected Member, 1882, 15.

Petroleum Fuel in Locomotives, 1884, 314.

BEELEY, T., elected Member, 1875, 314.

Rope Gearing, 1876, 394.

BEESLEY, D. S., elected Graduate, 1881, 164.

BEETLESTONE, G. J., elected Member, 1884, 198.

BEET-ROOT SUGAR MANUFACTURE in Belgium, 1883, 368. *See* Sugar.

BELGIAN MEETING, 1883, 307.—Reception at Liège, 307.—Business, 309.—Nomination of L. Trasenster as Honorary Life Member, 310.—Invitation of H.M. the King of the Belgians to the President, 311.—Votes of thanks, 313.—Reception at Antwerp, 313.—Excursions &c., 511.

BELGIAN RAILWAYS, Notes on, by P. Trasenster, 1883, 586.

BELGIAN ROLLING MILL for Plates, 1880, 84. *See* Plate Rolling Machinery.

BELGIUM, Works visited at Summer meeting, 1883, 511–585.

BELL, I. L., elected Vice-President, 1874, 26.—1875, 34.—1876, 26.—1877, 25.—1878, 29.—1879, 36.—1882, 32.—President, 1884, 21.



BELL, I. L. (continued).

Address, Presidential, 1884, 202.

Blast-Furnace Capacity, 1875, 358.

Blast-Furnace Working, 1882, 300, 304, 313.—1883, 141, 151.

Brakes, Continuous, for railway trains, 1878, 86.

Cardiff meeting, Reply to Mayor's welcome, 1884, 197.—*Address*, 202;

*See* Addresses of Presidents.—Reply to vote of thanks for Address, 226.

Council, Annual Report, 1884, 21.

Docks, Cardiff, 1884, 242.

Flow of Solids, 1878, 330, 337.

Injector, Automatic, 1884, 187.

Iron, Homogeneous, 1877, 80, 81.

Locomotive Running Shed, 1884, 254.

Locomotives, Fuel Consumption, 1884, 118.

Petroleum Fuel in Locomotives, 1884, 317.

President, on taking office as, 1884, 23.

Rules, 1878, 38.

Secretary, appointment, 1884, 77, 78.

Silver Ore Amalgamation, 1884, 268.

Steel Plant, Bessemer, 1881, 642, 648.

Tramways, Mechanical Traction, 1878, 427.

Tyne, *Paper* on the Tyne as connected with the History of Engineering, 1881, 425.

BELL, R. A., elected Graduate, 1884, 80.

BELL, W. H., elected Member, 1880, 310.

BELLAMY, C. J., elected Member, 1879, 155.

BELLHOUSE, E. T., decease, 1882, 17.—Mémorial, 1.

Presses, Hydraulic Packing, 1877, 369.

BELSHAM, M., elected Member, 1878, 293.

BELTS for transmitting power, 1881, 57. *See* Power Transmission.

BENDS IN RIVERS, Flow round, 1879, 456. *See* Flow.

BENHAM, P., elected Graduate, 1880, 10.

BENNETT, P. D., Council, Annual Report, 1884, 21.

Injector, Automatic, 1884, 179.

Rules, 1874, 31.—1876, 31.—1877, 30.—1884, 27.

Steel Plant, Bessemer, 1881, 644.

BENNETT, T. O., elected Member, 1877, 77.

BERGERON, C., elected Member, 1879, 37.—Decease, 1884, 3.—Mémorial, 61.

Compressed-Air Engines for Tramways, 1881, 674.

Locomotives, Franco's Fireless, for Tramways, 1879, 626, 638.

Railway Working, Economy, 1879, 146, 147, 150.

- BERGH, W., Centrifugal Separator, *Paper on a Centrifugal Separator for Liquids of different specific gravities*, 1882, 519.—Remarks, 523, 526.
- BERMUDA FLOATING DOCK, 1878, 180.
- BERRY, F., elected Member, 1875, 189.
- BESSEMER, H., elected Member of Council, 1874, 26.—1876, 26.
- BESSEMER STEEL PLANT, 1881, 627. *See* Steel Plant.
- BEWICK, T. J., elected Member, 1874, 256.  
Langley Barony Lead Mines, 1881, 618.
- BEWLEY, T. A., elected Member, 1882, 145.
- BEYER, C. F., decease, 1877, 2.—Mémorial, 16.
- BICHEROUX PUDDLING FURNACE, 1883, 541.
- BICKNELL, E., elected Member, 1883, 593.
- BIKA, L. J., elected Member, 1884, 1.
- BIRCH, R. W. P., elected Member, 1877, 77.
- BIRD, R., Mayor of Cardiff, Welcome to Members at Cardiff meeting, 1884, 197.  
—Vote of thanks to President for Address, 223.
- BIRKETT, H., elected Graduate, 1880, 310.
- BIRMINGHAM SEWAGE WORKS, 1876, 343.
- BISSET, W. H., elected Member, 1875, 314.
- BLACK, W., elected Member, 1879, 583.
- BLAKE, W. P., Flow of Solids, 1878, 328.
- BLAST-FURNACE CAPACITY, *Paper on the Ultimate Capacity of Blast-Furnaces*, by C. Cochrane, 1875, 334.—Definite curves showing the economy due to heat of blast and increased capacity, 334.—Insufficient blast pressure promotes scaffolding in furnaces, 335.—Results of working of large furnaces, 335.—Average working of Ormesby furnaces during five years, 339.—Excessive consumption corresponds to reduction in effective capacity, 340.—Calculation of weight of escaping gases, 341.—Increased temperature of escaping gases corresponds to reduction in effective capacity of furnace, 342.—Successful trial of large 40,000 cub. ft. furnace rendered impossible by excessive scaffolding, 343.—Investigation of effective working capacity of furnaces during five years, 343.—Economy by capacity and by extra temperature an established fact, and not replaceable items up to 20,000 cub. ft. capacity, 349.—Furnace of 33,000 cub. ft. capacity worked within 0.44 cwt. of calculated duty, 353.—Wrought-iron casings for blast furnaces requisite for preventing continued insensible leakage of gas, 354.—Large furnaces require increased pressure of blast, 354.—Appendix showing mode of calculating weight of escaping gases, 355.  
*Discussion.*—Cochrane, C., Importance of reduction in temperature of escaping gases, 357; capacity and temperature not replaceable, 357; hot-blast stoves, temperature obtained, 358.—Bell, I. L., Three sources of heat in blast furnaces, 359; no practical difference in temperature of escaping

## BLAST-FURNACE CAPACITY (continued).

gases from furnaces of different capacity, 361; corrected calculation of heat passing off with escaping gases, 362; variation in heat evolved by combustion of coke, 363; limit to benefit gained by retaining heat of escaping gases, 363; result of working of large furnace not correct, 364; deposition of carbon in working with light burden requires a week to work off on changing to heavy burden, 367; increased temperature of blast of no advantage above a certain point, 368; estimate of theoretical minimum consumption of coke per ton of pig, 369; kind of coke used affects rate of consumption, 370; iron casings for furnaces objectionable, 371; examination of contents of furnace by series of apertures in the side, 371; capacity of furnace and temperature of blast are mutually replaceable, 372.—Cowper, E. A., Curves given of temperature and capacity substantially correct, 373; reduction in consumption of coke with increased temperature of blast, 373.

*Adjourned Discussion.*—Siemens, C. W., Ultimate capacity not to be considered as an abstract principle, 1876, 33; chemical action not affected by difference of capacity, 33; chemical conditions mainly to be considered, 34.—Cowper, E. A., Advantage of increased capacity in gaining a heating zone, 35.—Cochrane, C., Possible reduction of temperature in escaping gases, 35; result of scaffolding in reducing effective working capacity of furnace, 37; proportion of carbonic acid and carbonic oxide in escaping gases, 38; loss by escape of gas from sides of furnace, 40; increased capacity of furnace to absorb sensible heat beyond region of chemical action, 42.—Hawksley, T., Mechanical crushing of materials by absolute weight in furnace, 44.

BLAST-FURNACE TUYERES. *See* Tuyere, Open Spray, 1876, 350.

BLAST-FURNACE WORKING, *Paper* on the Working of Blast-Furnaces of large size, at high temperatures of blast, with special reference to the Position of the Tuyeres, by C. Cochrane, 1882, 279.—Size of hearth, and overhang of tuyeres, 280.—Diminution in effective capacity of furnace with tuyeres too close, 281.—Particulars of four furnaces under observation, 281.—Distribution of ascending currents of gas, 282.—Improved working of No. 4 furnace after withdrawal of tuyeres, 283.—Reduction of pressure in hearth from circumference to centre, 284.—Concentration of ascending gases towards centre of furnace, 285.—Insufficient access of reducing gas to circumference of furnace, 286.—Beneficial results from drawing back the tuyeres, 286.—Similar results at No. 2 furnace, 287.—Ring-scaffold at top of bosh, 288.—Curve of furnace capacity and coke consumption, 290.—Distribution of pressure in hearth of No. 1 furnace, 291.—Gauge tube for ascertaining pressures, 292.—Limit to distance of tuyeres, 293.—Limit to tuyere area, 294.—Relation between tuyere area and blast temperature,

## BLAST-FURNACE WORKING (continued).

295.—Distribution of temperature in hearth, 295.—Nature of materials operated upon, 297.—Escaping gases are not absolute guide to working of furnace, 297.

*Discussion.*—Cochrane, C., Arrangement of materials in furnace top under charging bell, 298; calculation of furnace capacities, 299; financial economy from drawing back the tuyeres, 299; results of enlarging tuyere area, 299; results in paper confirmed by subsequent working, 299.—Bell, I. L., Temperature in author's furnaces not very high, 300; effect due to overhang of tuyeres, 300; blast pressure in hearth, 301; curve of furnace capacity and coke consumption, 302; escaping gases are infallible guide to working of furnace, 303; analysis of gases from Ormesby furnaces, 304.—Cochrane, C., Gases analysed were taken off before withdrawal of tuyeres, 304.—Richards, E. W., Analysis should be given notwithstanding, 304.—Bell, I. L., Heat absorbed in production of Cleveland pig iron, 304; heat generated and utilised in low and in high furnace, 305; comparative performance of Ormesby and Clarence furnaces, 306; composition of escaping gases at Ormesby furnaces, 307; estimate of blast and coke consumption with improved working, 308; value of hotter blast real, but overrated, 309.—Cowper, E. A., Reduction in coke consumption by hotter blast, 310; higher pressure of blast for larger hearth, 310.—Richards, E. W., Height of furnace should be considered, besides capacity, 310; reduction in coke consumption could not be due to withdrawal of tuyeres, 311; saving effected by increased height, 311; good effect of hotter blast in high furnaces, 311; position of tuyeres in Cleveland, 312; large make in American furnace, 312.—Williams, E., Is furnace still in existence, 312.—Richards, E. W., Make due to large blast, 312; furnace expected to last two years, 313.—Bell, I. L., Greater value of hotter blast in lower furnaces, 313; proper make for Cleveland furnaces, 314; disadvantage of enormous make in American furnaces, 314.—Cochrane, C., Mechanical character of paper, 314; correctness of statement of coke consumption prior to withdrawal of tuyeres, 315; distribution of blast pressure in closed or in open hearth, 315; lower proportion of make to capacity in Ormesby furnaces, 316; results at No. 3 furnace, 317; better duty both from increased capacity and from hotter blast, 317.—Westmacott, P. G. B., Interest of subject to mechanical engineers, 317.

BLAST-FURNACE WORKING, *Paper* on the Working of Blast-Furnaces, with special reference to the Analysis of the Escaping Gases, by C. Cochrane, 1883, 93.—Conditions governing economy of fuel in blast furnaces, 93.—Temperature of blast, 95.—Temperature of escaping gases, 97.—Maintenance of carbon in form of carbonic acid, 100.—Impossibility of ascertaining real working

## BLAST-FURNACE WORKING (continued).

of furnace from mere analysis of escaping gases, 106.—Ideal work of perfect furnace, 106.—Effect of transfer of carbon from carbonic acid to carbonic oxide, 107.—Calcining of limestone before charging, 112.—Breaking down lumps of ironstone before charging, 112.—Ratio of carbonic acid to carbonic oxide as affected by carbonate of lime, 114.—Influence on consumption of carbon of perfectly calcined ironstone descending into red-hot coke region, 115.—Influence of imperfectly calcined ironstone on consumption of carbon, 116.—Disposal of heat in furnace, 117.—Limit of coke consumption in Cleveland blast furnaces, 123.—Tables A-K, 124-134.

*Discussion.*—Rennie, G. B., Great amount of information given, 135.—Cochrane, C., Impossible for carbonic acid to exist in hearth of blast furnace, 135; small consumption of fuel in Austrian charcoal furnaces, 136; breaking up of ironstone for large furnaces, 136; calculation of consumption of coke in blast furnace, 137.—Stead, J. E., Mode of calculating consumption of carbon, 138; value of gas analysis, 140.—Cochrane, C., Value only in conjunction with coke consumption, 141.—Bell, I. L., Data supplied for Grüner's work on blast furnaces, 141; influence of furnace capacity upon temperature of escaping gases, 142; two foci of heat generation in blast furnace, 142; absorption and evolution of heat near top of furnace, 142; loss of heat in escaping gases nearly constant in larger furnaces, 143; value of chemical analysis, 144; corrections required in tables owing to variations in quantity of blast, 145; both temperature of blast and state of oxidation of carbon must be taken into account, 146; loss by interruption in charging of furnace, 146; maintenance of carbon in form of carbonic acid, 146; coke consumption can be ascertained from gas analysis, 148; economy of fuel to be expected in blast furnaces, 149; use of calcined limestone, 149; lumps of ironstone split up in descending through furnace, 150.—Cowper, E. A., Instances of ironstone passing through furnace unreduced, 151; economy in coke consumption by very hot blast, 151.—Bell, I. L., Ironstone ordinarily becomes split up in passing through furnace, 151.—Stead, J. E., Confirmation of splitting up of ore, 151.—Paget, A., Question of actual coke consumption, 152.—Cochrane, C., Influence of furnace capacity on temperature of gases, 152; gas analysis alone insufficient to indicate consumption, 153; general correctness of tables, 153; limit of ratio of carbonic acid to carbonic oxide for reduction of ore, 154; lumps of ironstone can be deoxidised without becoming split up, 154.—Rennie, G. B., Thanks to Mr. Cochrane and to Mr. Bell, 154.

BLASTING OPERATIONS, at granite quarries, Loch Fyne, 1879, 580.

BLAST-FURNACES, visited at Barrow meeting, 1880, 481, 484, 486.

BLECHYNDEN, A., elected Member, 1881, 163.



BLOWER, Applications of Roots' Blower, 1877, 92.

BLUE JACKET, Steamer, 1884, 347, 348; visited at Cardiff meeting, 356.

BLUNDSTONE, S. R., elected Graduate, 1882, 255.

BOARD OF TRADE REGULATIONS, resolution respecting, 1878, 563.

BOCQUET, H., elected Graduate, 1884, 80.

BOCQUET, W., elected Member, 1881, 624.

BOCHUM WORKS, castings in hard steel, 1880, 172.

BODDEN, G., elected Member, 1883, 309.

BOILER AND ENGINE, HIGH-PRESSURE, *Paper* on Steam Boilers and Engines for High Pressures, by L. Perkins, 1877, 117.—Means of combining great strength and safety with durability in boiler for very high pressures, 117.—Securing soundness of joints, 118.—Construction of boiler, 119.—Arrangement for using the high-pressure steam in the engine, 120.—Ordinary mode of packing for piston not suitable, 121.—Compound metal for packing rings without lubrication found very successful, 121.—Result of working, 121.—Construction of surface condenser, 122.—Still for replacing waste of fresh water, 122.—Special points to be noticed, 123.

*Discussion.*—Perkins, L., Connections of boiler tubes, 124.—Olrick, L., Proper circulation in boilers is a very material point, 126; great advantage in absence of lubrication, from special metal employed for packings, 127.—Ravenhill, J. R., Action of distilled water on wrought-iron plates found to be extremely rapid, 128; objection to small vertical connecting-tubes in boiler, 128; difficulty in taking out portion of boiler for repairs, 128.—Paget, A., Boiler worked for long time with rain water without injury, 129.—Ravenhill, J. R., Proof of injurious action of distilled water in boiler, 129.—Young, C. F. T., Action of pure water on wrought-iron plates depends much on pressure and temperature in boiler, 130.—Head, J., Rain water contains sufficient carbonic acid to dissolve carbonate of lime, which is not soluble in pure water, 130.—Marten, E. B., Mr. Perkins' boiler the best type of the small boiler principle, 130; freedom from priming, 131; Lancashire boiler will no doubt continue to do bulk of steam-producing work, 131; very high pressure required however in many cases, 131; circulation not wanted in boiler described, 132; great corrosion caused outside boilers by distilled water from leaky fittings, 132.—Chapman, H., Possible prevention of boiler corrosion by deposition of magnetic oxide, 132.—Adamson, D., Limit to reduction in water contents of boiler advisable, 133; rapid ebullition caused by sudden drop in pressure, 134; high temperature a source of danger from reducing strength of plates, 134; compound cylinders more economical than single cylinders, 135; advantage in quadruple action, 137; water should be pure before being distilled for working high-pressure, 137.—Crampton, T. R., Important to consider proportion of heating surface to water evaporated, 137;

**BOILER AND ENGINE, HIGH-PRESSURE, (continued).**

desirable to limit steam-pressure and degree of expansion, 138; great wear and tear of engines and boilers with very high pressures, and only small gain of fuel, 139.—Cochrane, C., Roots' boiler found by experience to be safe and sure, 140; corrosion of boiler not caused by pure water, but by acids from oils of engine, 140; boiler with small water spaces must be limited to high pressures, otherwise could not get rid of steam generated, 140.—Flannery, J. F., Metal employed for packing has successfully overcome difficulty in using very high-pressure steam, 141; difficulty in boiler working well without special care, 141.—Hawksley, T., Metal employed for piston packing-rings working without lubrication would answer well for the air engine, 142.—Welch, E. J. C., Number of cylinders must depend on ultimate range of temperatures between boiler and condenser, 143; jacketed engine yields much better results than unjacketed, though exact saving not easy to calculate, 144; no relation between horse power of engine and that of boiler, 144; formula for areas of cylinders to give out equal power to crank shaft, 145; balancing very important for all engines, 146.—Ellington, E. B., Steam-jacketing of low-pressure cylinder not any advantage, but rather the opposite, 146.—Cowper, E. A., True expansion curve for steam, 147; advantage of good vacuum, 147; small advantage from increase of pressure beyond moderate limit, 148; instance of very low consumption in engine with moderate pressure, 148.—Hildebrandt, J. A. R., Low-pressure steam preferable to high-pressure under certain circumstances, 149; really pure water without any oxygen has no effect upon iron, 149; rain water contains both carbonic acid and ammonia, 149.—Crompton, R. E. B., Fittings of boiler and pump valves at a high pressure liable to give trouble, 149.—Perkins, L., Pure water in a hot boiler has no effect upon iron, 150; proof of strength of joints in boiler, 151; no trouble from heating of tubes, 152; temperature not sufficient to injure the iron, 153; no difficulty caused by brittleness of special metal for piston packing-rings, 153; necessary to prevent any grease being put into engine, 154; high-pressure heating apparatus, 155.—Bramwell, F. J., Successful action of heating apparatus, 155.—Hawksley, T., Pure water, so long as it remains pure and free from oxygen, is not the cause of corrosion, 155; fatty acids from grease must be excluded from boiler, 155; piston bearing-surface should be made deep, 156; importance of low-pressure cylinder being jacketed, as well as high-pressure, 157.

**BOILERS, Comparative Efficiency, 1884, 108.** See *Locomotives, Fuel Consumption.*

**BOILERS, Non-conducting Covering, 1874, 277.**

**BOILER CORROSION, Paper on the Causes and Remedies of Corrosion in Marine Boilers, by J. H. Hallett, 1884, 331.**—Corrosion chiefly due to defective

# BOILER CORROSION (continued).

design or management, 331.—Faults of design, 331.—Want of space for examination, 331.—Position of manholes, 332.—Pitching of steam-space stays, 332.—Management, 332.—Circulation, 332.—Racking strains in double-ended boilers, 333.—Scum-pipe and blow-off cock, 333.—Renewal of water, 333.—Treatment of new boilers, 334.—Results of want of proper care, 334.—Corrosion from use of lubricants in engines, 335.—Remedies for preventing corrosion, 335.—Hannay's electrogen, 335.—External corrosion, 336.—Position of fire-bridges, 336.—Treatment of boilers in vessels when laid up, 336.

*Discussion.*—Fothergill, J. R., Defects in design, 337; bad management, 337; corrosion from air in feed-water, 337; oily matter in boiler-scum and mud, 338; pitting by oil and grease, 338; impregnation of water in boiler bottoms, 338; position of feed-pipe, 339; remedy for pitting, 339; lubrication of piston-rods, 339; objection to blowing out hot boilers, 339; mineral oils for internal lubrication, 340.—Walker, S. F., Pitting from galvanic action, 340; corrosion by gases from decomposed salts, 341; prevention by slabs of zinc, 341; zinc must be pure, 341; amalgamated zinc, 341; zinc-copper couple is more powerful than zinc-iron couple, 342; suspended plate of iron fed by external electric current, 343.—Jacobs, C. M., Corrosion dates from introduction of high pressures and surface condensers, 343; use of petroleum and cement in badly pitted boiler, 343.—Marshall, F. C., Pitting in empty boilers not left dry, 344; corrosion in line of fire-bars, 346; exclusion of air from boilers, 346; petroleum as a preventive of corrosion and of priming, 346; corrosion in steel boilers, 346.—Hallett, J. H., Non-lubrication of cylinders, 347; treatment of pitted plates, 348; efficiency of electrogen, 348; local currents from variations in quality of plates, 348; corrosion due to free gases in water in presence of salt, 348; waste of cast zinc, 349; failure of amalgamated zinc, 349; good results from careful management, 349; corrosion from solid matter in boiler bottoms, 350; priming from delivery of feed-water into steam-space, 350; blowing-down boilers, 350.—Bakewell, H. J., Admiralty practice in treatment of marine boilers, 351; access for examination, 351; good material, 351; causes of internal corrosion, 351; methods of protection, 351; treatment of boilers when not in use, 352; working density and condition of water in boilers, 352; sudden changes of temperature, 353; use of mineral oil, 353; slabs of rolled zinc for preventing corrosion, 353; periodical examination and tests, 354; examples of boilers under Admiralty treatment, 354; table of results, 355.

BOILER FEEDER, *Paper* on the Fromentin Automatic Boiler Feeder, by J. Hayes, 1882, 479.—Disadvantages of feed-pumps and injectors, 479.—Description

**BOILER FEEDER (continued).**

and action of Fromentin feeder, 480.—Construction of disc-castings and arrangement of ports, 482.—Application to different kinds of boilers, 483.—Experience of working, 484.—Advantages, 484.

*Discussion.*—Hayes, J., Arrangements of dip-pipes for varying the water-level in boiler, 485; letter from M. Tresca, 486; report by M. Couronne, 487.—Westmacott, P. G. B., Whether feeder tried with dirty water, 488.—Hayes, J., Water not clean, 488.—Kitson, J. H., Satisfactory trial of feeder in Leeds, 488; advantageous for forge boilers, but not for range of boilers, 489; variation of pressure in range of boilers, 489.—Westmacott, P. G. B., What was the pressure, 489.—Kitson, J. H., Particulars of variation, 489.—Webb, F. W., Steam-pipes and pressure-gauges, 489.—Kitson, J. H., Steam-pipes communicate, and pressure-gauges were tested, 489.—Marten, E. B., Furnace boiler or fired boiler, 490.—Kitson, J. H., Feeder applied to fired boiler, 490.—Anderson, W., Feeder as working in London, 490.—Head, J., Automatic action found best, 491; advantage of feeder as a tell-tale of boiler-working, 491; general recognition of self-acting principle, 492; difficulty in applying feeder to vertical forge-boilers, 492; advantage of feeder as water-meter, 492; need of alarm apparatus, 493.—Paget, A., Feeder as likely to get out of order as injector or pump, 493; leakage between port-faces, 493; loss of heat by radiation from bottles, 494; injectors not generally supplied in duplicate, 494; liability to deposit, 494.—Cochrane, C., Failure of another feeding apparatus after thirty years, 494.—Halpin, D., Steam engine at present inferior to boiler in efficiency, 495.—Hayes, J., Application of feeder to range of boilers, 495; working of feeder in London, 495; use of feeder as water-meter, 496; alarm apparatus, 496.—Westmacott, P. G. B., Risk of choking up with deposit, 496.—Hayes, J., Freedom from sediment in feeder, 497.—Paget, A., Quality of water, 497.—Hayes, J., Water from mains will leave scale, 497; neither lubrication nor attention required, 497; economy realised, 497.—Cochrane, C., Risk of scale gathering on dip-pipe, 498.—Hayes, J., No choking of dip-pipe, 498; size of dip-pipe, 499; absence of floats or levers, 499; advantage of feeder to both boiler and engine, 499.

**BOILER FEEDER**, Mayhew's Automatic, shown at Cardiff meeting, 1884, 357.

**BOILER**, Feed-Water Heater and Filter, 1881, 539.

**BOILERS**, Experimental boilers of mild steel, 1880, 405, 413, 483.—Of Steam-ship "City of Rome," 1880, 342. *See* Steam-ship.

**BOILERS**, Frisbie's Mechanical Fire-feeder and Grate for Boilers and Furnaces, 1876, 318.

**BOILER**, LANCASHIRE, *Paper* on the Lancashire Boiler, its construction, equipment, and setting, by L. E. Fletcher, 1876, 59.—Lancashire and Cornish boilers, 59.—Boiler should have as much accuracy of make and attention as



# BOILER, LANCASHIRE (continued).

engine, 60.—Variations in construction, 61.—Experimental boiler for series of hydraulic bursting tests, 61.—Construction of boiler recommended for high pressures, 62.—Grooving action at ends, 63.—Gusset stays, 63.—Mode of testing, 63.—Longitudinal stays, 64.—Elasticity of end plates, 64.—Furnace tubes, means of strengthening, 65.—Objection to stays for supporting furnace tubes, 66.—Shell plates, 67.—Steam dome useless and objectionable, 68.—Manhole strengthened with wrought-iron mouthpiece, 68.—Fitting of safety-valves, 70.—Blocks for attachment of fittings, 70.—Seams of rivets, 71.—Strain on transverse seams only half that on longitudinal seams, 71.—Machine riveting and drilled holes preferred, 71.—Material for boiler, 72.—Arrangement of fittings, 73.—Dead-weight safety-valve, 74.—Low-water safety-valves, 74.—Furnace mountings, 75.—Setting, flues, and course of draught, 76.—Boiler covering, 78.—Connections, 78.—Weight and cost, 79.—Heating surface, 80.—Working results, 81.

*Discussion.*—Fletcher, L. E., Specimens from experimental boiler, 82; effect of hot fire on Lancashire boiler, 82; leakage in furnace tubes stopped by removing rigidity of ends, 84; objection to grouping safety-valves and other fittings on one mouthpiece, 84; necessary to plug junction-valve when examining boiler, 85; explosion from fracture of branch steam-pipe, 86; cast-iron fitting blocks objectionable, 87.—Cowper, E. A., Gauge cocks essential in case of glass gauge breaking, 88; vacuum-valve useful for preventing boiler filling with water when steam down, 88; steam dome should not be done away with, but boiler shell strengthened, 88.—Adamson, D., Relative area of plate and rivet in experimental boiler not proportioned to give greatest strength, 89; objection to system of specifying diameter of rivets, 90; usual tests of small riveted pieces not reliable, 90; with punched holes many rivets not in true position to give full strength, 90; punched holes no advantage from being conical, 91; original introduction of flanged seams, and gusset stays, 92; flanged seams proportioned to stop collapse of flue when overheated, 92; flanged seams could bear more intense heat than any other seam, 92; uniformity of strength desirable even by chain-riveting transverse seams, 94; longitudinal stays valuable as a precaution, 94; elasticity of plates more important than tensile strength, 94; plates should be tested across grain, 95; wrought-iron mouthpieces long adopted in locomotive boilers, 96; drilled rivet holes give greatest strength because all rivets act fully, 96.—Walker, B., Drilled holes found better than punched, 97; Lancashire boiler found satisfactory in working, 97; longitudinal bolts add materially to durability and safety of boiler, 98; cast-iron mountings satisfactory when not badly put on, 98; holes drilled and riveted cold found stronger than holes punched and riveted hot, 99.—



## BOILER, LANCASHIRE (continued).

Olrick, L., Best construction of boilers should always be employed, 99; proportion of test pressure to working pressure, 100; longitudinal stays should only take strain after gusset stays, 100; means of strengthening manholes in vertical boilers, 100; large mudhole obtained in Cornish boiler by adding a large pocket, 101; material for boiler shells, 102; additional safety-valves for preventing excessive pressure, 102; evaporative power of boiler should be stated, not horse power, 103; experiments on boilers should be extended to vertical boilers, 103.—Head, J., Sources of danger in Lancashire boiler, 104; dangers lessened in vertical boiler, 105; results of working with vertical boilers, 105; advantages of vertical boiler over Lancashire, 106; cross tubes in vertical boilers, 108.—Cochrane, C., Internal corrosion from acidity of water prevented by use of caustic soda, 108.—Hall, W. S., Strength of joints not equal along zigzag and along straight line of rivets, 109.—Welch, E. J. C., Means of punching rivet-holes at exact distances, 109; drilled holes stronger than punched, 110; steam junction-pipe broken from water accumulating, 110; low water alarms not to be relied on, 111; rules for strength of internal flues in boilers, 111; test by hydraulic pressure should not be less than double the working pressure, 112.—Walker, C. C., Priming a great danger, which ought to be got rid of, 113; horizontal boiler better than vertical for avoiding priming, on account of large water surface, 114.—Robinson, J., Vertical boilers worked at Manchester not found satisfactory, 114; priming considerable in vertical boilers, 115; danger of steam getting superheated and causing explosions in vertical boilers, 115.—Head, J., Vertical boilers with considerable amount of steam pipe found not to prime, 115; uptake going through steam not dangerous with proper construction, 116.—Thornycroft, J. L., Vertical boilers liable to priming from small water surface, 117.—Paget, A., Best construction of riveted joint very desirable to be ascertained, 117.—Platt, J., Drilled holes more correct than punched holes, but question whether worth extra expense, 118; cast-iron mountings riveted on by hydraulic machine, found to be very perfect work, 119.—Hall, T. B., Flanged seam admirable for strengthening boiler flues, but disadvantageous in repairs, 119.—Bower, A., Defects in Board of Trade rules for boilers, 119; experiments required for establishing best riveted joints, 120; plates should be planed at edges, and rivet holes drilled, 120.—Amos, C. E., Means of overcoming difficulty of priming, 121.—Fletcher, L. E., Advantages of Lancashire boiler for mills, 121; dangerous character of vertical boilers, 122; longitudinal stays not required for strength, 123; factor of safety adopted, 124; weakening effect of steam dome, 124.—Hawksley, T., Self-acting feed for furnace should be considered in construction of boiler, 125.

- BOILERS, Iron and Steel for, 1879, 268. *See* Iron and Steel for Boilers.
- BOILERS, Marine; *see* Marine Engine. For iron or steel works; *see* Steel Plant.
- BOILERS, Steel. *See* Steel Boiler Experiments. *See* High-Pressure Vessels.  
*See* Iron and Steel for Boilers.!
- BOILER, RAG, for paper making, 1876, 129, 157.
- BONE, W. L., elected Member, 1884, 1.
- BOOTH, W. S., elected Graduate, 1883, 310.
- BORING by Diamond Drill. *See* Rock Drill, Diamond, 1875, 92. *See also* 1874, 249.
- BOBING by Percussive Drill. *See* Rock Drilling Machinery, 1874, 77.—1877, 206. *See also* 1875, 103, 109, 111, 113. *See* Mining Machinery, 1882, 319.
- BORODIN, A., elected Member, 1880, 185.  
 Locomotives, Compound, 1883, 451, 452.
- BORRIE, J., memoir, 1884, 398.
- BOUCH, W., decease, 1877, 2.—Memoir, 17.
- BOUCH, Sir T., decease, 1881, 11.—Memoir, 1.
- BOURDON, F. E., elected Member, 1878, 558.
- BOURNE, J. J., elected Member, 1884, 198.
- BOURNE, W. T., elected Member, 1879, 37.
- BOUSFIELD, W. R., *Paper* on Implements and Machinery for Cultivating land by Horse-Power, 1880, 529.—Remarks, 547, 551.
- BOVEY, H. T., elected Member, 1879, 37.
- BOW, W., elected Member, 1880, 310.
- BOWER, A., Boiler, Lancashire, 1876, 119.
- BOWIE, A. J., Jun., elected Member, 1882, 254.
- BOWLES, E. W., elected Graduate, 1882, 476.
- BOYD, W., elected Member of Council, 1884, 21.  
 Council, Annual Report, 1884, 21.  
 Dock, Victoria Floating, 1878, 180.  
 Governor, the "Velometer," 1879, 415.  
 Petroleum Fuel in Locomotives, 1884, 300.  
 Riveted Joints, 1881, 263.  
 Slipways, *Paper* on Slipways, 1881, 581.  
 Steam-ship "City of Rome," 1880, 345.  
 Steel Boiler Experiments, *Paper* on experiments relative to Steel Boilers, 1878, 217.—Remarks, 267, 269.  
 Valve-Gear, Joy's, 1880, 437, 440.
- BOYER, R. S., elected Member, 1884, 79.
- BOYS POWER METER, 1884, 107.
- BRACONNOT, Capt. C., elected Member, 1875, 35.—Decease, 1883, 36.—Memoir, 11.
- BRADBURY AND Co.'s Sewing Machine Works, Oldham, 1875, 307.
- BRADFORD, Works visited at Leeds meeting, 1882, 452, 466-7.
- BRADLEY, F., elected Member, 1882, 145.

BRADLEY, F. A., elected Member, 1878, 30.

BRADLEY, I., elected Member, 1875, 65.

BRADLEY, T., elected Member, 1881, 9.

BRAGGE, W., memoir, 1884, 398.

BRAHAM, P., Expansion, Variable Automatic, 1877, 291.

Tynewydd Colliery Inundation, 1877, 232.

BRAITHWAITE, C. C., elected Member, 1878, 107.

BRAITHWAITE, R. C., elected Member, 1875, 65.

BRAKE, *Paper on the Automatic Screw-Brake*, by W. Parker Smith, 1882, 500.

—Hand screw-brake and continuous brakes, 500.—Weak points in early mechanical brakes, 501.—Use of fluid pressure, 501.—Principle of automatic screw-brake, 501.—Construction and action, 502.—Arrangement for vehicles with small wheels, 504.—Application of brake by engine-driver or guard, 505.—Freedom from skidding, 505.—Independence of brakes on each vehicle, 506.—Complication of air or water brakes, 506.—Screw-brake is normally *on*, 507.—Brake put fully on in two or three revolutions of axle, 507.—Weight of apparatus, and facility of fitting, 507.—Wearing surfaces, size and durability, 507.—Large field for mechanical brakes, 508.

*Discussion.*—Smith, W. P., Exhibited model of brake, and parts of apparatus, 508.—Westmacott, P. G. B., Want of satisfactory brake, 508.—Smith, W. P., Particulars of running and of stops, 509.—Head, J., Skidding, and limit of pressure, 509.—Smith, W. P., Wheels not necessarily skidded, 509.—Ramsbottom, J., Ballast on Liskeard and Caradon Railway, 509.—Smith, W. P., Broken granite, with little sand, 509; screwed sleeve does not touch axle, 509.—Ramsbottom, J., Difficulties from rusting, exposure, and dust, 510; each brake in long train should do its share in retarding, 510.—Tomlinson, J., Use of Smith vacuum brake on Metropolitan Railway, 510; sudden action of screw-brake, and difficulty of keeping blocks in trim, 511; short stroke with screw-brake, 511.—Davey, H., Possibility of excessive pressure after skidding, 511; small traffic on Liskeard and Caradon Railway, 512.—Fairholme, C., Steel friction-surfaces in Heberlein brake, 512; hand-brakes cannot be replaced by air-brakes, but are replaced by Heberlein, 512; brake-couplings by cord above coaches, 513; difference between Heberlein and Clark-Webb brake, 514.—Crampton, T. R., Do screws wear unequally, 514.—Riches, T. H., Brake-couplings between carriages, 514; objection to use of chains, 515; self-contained automatic brake on each vehicle, 515; Foulkes' brake, 515; difficulty of applying continuous brake to goods trains, 515.—Smith, W. P., Couplings between vehicles prevent all movement in chain, 515; chain preferable to rope, 516; effects of exposure to weather, 516; unequal application of brakes throughout

## BRAKE (continued).

train, 516; gradual action of screw-brake, 517; large stroke can be obtained, 517; no skidding occurs in practice, 517; mode of working the brake, 517; cost and weight of apparatus, 518; continuous brakes for express goods trains, 518.

BRAKE, Foulkes' Continuous Automatic Railway Brake, shown at Cardiff meeting, 1884, 357.

BRAKES, *Paper on Continuous Brakes for railway trains*, by R. D. Sanders, 1878, 67.—Principle of different brakes alone considered, 67.—Simple and automatic method of applying brakes, 68.—Screw brake, 68.—Chain brakes, 69.—Simple vacuum brake, 71.—Brake should be under control of driver, 73.—Contingencies to be provided against in working a train, 74.—Four conditions necessary for perfect system of continuous brakes, 74.—Hydraulic brake, 75.—Automatic compressed-air brake, 76.—Another form of ditto, 79.—Automatic vacuum brake, 79.

*Discussion.*—Sanders, R. D., Requisite pressure to be first studied, and then means of applying it, 81.—Olrick, L., Brake-blocks should be held away from wheels, 82; importance of promptness of action with brakes, 83; experiments in stopping with Westinghouse and vacuum brakes, 83; hardly fair to compare compressed-air brake against vacuum brake, 84.—Paget, A., Brake with more pressure reasonably compared with vacuum brake, 84.—Welch, E. J. C., Advantage of pressure over vacuum brake, 85; cylinder with piston seems more durable than diaphragm, 85.—Barclay, A., Maximum pressure on brake-blocks can do no more than skid the wheels, 85; continuous brakes should be applied to slow trains, 86.—Bell, I. L., Question to be discussed is that of best brake, 86; difficulties of North Eastern Railway, 87.—Tomlinson, J., Saving effected with continuous brake, 87.—Unwin, W. C., Continuous brakes of Newall and Fay, 89; air-pressure brake has decidedly greater retarding power than vacuum brake, 90.—Wright, W. B., Defects of Newall's and Fay's brakes, 90.—Paget, A., De-railment not uncommon, except with short runs and low speeds, 91.—Tomlinson, J., Automatic action complicated and seldom wanted, 92.—Wright, W. B., Automatic principle valuable, apart from question of breaking away, 92.—Hawksley, C., Brakes more effective when wheels not completely skidded, 93.—Westinghouse, G., Jun., Greater pressure always gave better results, 94; pressure should be more than double weight on wheel, 94; Westinghouse brake and triple valve, 95; comparison with vacuum brake, 96; results of working most satisfactory, 97; brake can be graduated with great nicety, 98.—Cowper, E. A., Brake ought to be capable of being put on gradually, 98; adhesion between wheel and rail, 99.—Robinson, J., Discomfort caused by application of chain brake on London and North Western Railway, 99.—

## BRAKES (continued).

Welch, E. J. C., Diaphragm must have three times as large area as piston, in order to have same effect, 99.—Cowper, E. A., Life of diaphragm, 100.—Sanders, R. D., Promptness of application of automatic vacuum brake, 100; results of actual trials, 101; Westinghouse brake sometimes goes on when not wanted, 102; pressure produces same effect, however applied, 102; advantages of automatic vacuum brake over compressed-air brake, 103; construction of diaphragm, 104.—Robinson, J., Question of best brake not yet settled, 105.

BRAKES, *First Paper* on the Effect of Brakes upon railway trains, by Douglas Galton, 1878, 467. — Paper gives results of experiments on Brighton Railway, 467.—Objects of experiments, 467.—Construction of dynamometer used, 468.—General arrangement of recording apparatus, 470.—Speed indicator, 470.—Description of diagrams obtained, 472.—Results shown by the experiments, 477.—General conclusions, 478.

*Discussion.*—Galton, D., Delay in making apparatus prevented paper being complete, 479; line of speed, 479.—Morin, General, Desired opportunity for reflection before giving opinion, 480.—Westinghouse, G., Jun., Rise in friction of brake-blocks when just stopping, 480; no partial skidding, 480; brakes might operate with much greater force than has been applied, 481; actual weight upon wheels to be recorded, 482; essential point is to settle exact diagram of brake-block pressure, 482.—Haswell, J. A., Results of paper as to skidding negated the deductions drawn by Royal Commission on railway accidents, 483.—Tomlinson, J., Experiments only confirmed what was known by practical men about skidding of wheels, 483.—Brown, C., Accident on a line in Switzerland showed that the retarding effect is much less with skidded wheels, 484.—Pontzen, E., Duration of skidding is an item to be noticed, 484.—Yeomans, D. M., Application of brakes should be quick but gradual, 485.—Cochrane, C., Distribution of load on wheels would be altered by momentum, 485.—Darwin, H., Question of distribution of load had been considered, 486.—Paget, A., Skidding as affected by material of wheels and rails, 486.—Hawksley, C., Possible means of obviating skidding, 486.—Kennedy, A. B. W., Cause of diminished resistance with skidded wheels is polishing of surface, 487.—Robinson, J., Skidding might sometimes be used with advantage, 488.—Galton, D., Difficult matter to apply brakes without sometimes skidding the wheels, 488.—Robinson, J., Paper is the result of great labour, 489.

BRAKES, *Second Paper* on the Effect of Brakes upon railway trains, by Douglas Galton, 1878, 590. — Alterations in apparatus, 590.—Modification of conclusions as to instantaneous skidding, 592.—General description of subsequent experiments, 592.—Two conditions of retardation, according



## BRAKES (continued).

as wheels are skidded or not, 593.—Coefficient of friction between brake-blocks and wheels, 594.—Special experiments with brake-blocks of small area, 595.—Time occupied in skidding wheels varies with speed, 596.—Sudden rise and fall in friction at moment of skidding, 597.—Coefficient of friction varies with time of application, 598.—Table of coefficients of static and dynamic friction, 599.—Friction of wrought-iron blocks, 600.—Effect of sand on rails, 600.—Coefficient of friction between wheels and rails, 601.—General effect of brakes, as shown by strain on draw-bar, 602.—Proportion which pressure on brake-blocks should bear to weight on wheels at different velocities, 604.—Effect of time expended in bringing pressure to bear on wheels, 606.—Description of experiments with Smith brake and Westinghouse brake, 607.—Time expended in applying the two brakes at different points in train, 610.—Particulars of stops made in experiments, 611–613.—Conclusions, 614.

*Discussion.*—Galton, D., Second day's results with vacuum train not reliable, 616.—Robinson, J., Additional observations prepared by the Secretary, 616.—Browne, W. R., *Supplementary Paper on the Theory of the action of Brakes upon the wheels of a train*, 617; motion of wheel rolling on rail, 617; retarding effect of brake equal to frictional strain, 618; wheel is skidded when block friction exceeds rail friction, 619; change of friction as wheel comes to rest, 619; decrease of retarding force when wheel is skidded, 620; further decrease as skidding continues, 620; effect of releasing wheel, 620; variation of friction with speed and time, 621.—Sacré, C., Desirable to ascertain cost of working of various brakes, 621.—Haggard, F. T., Apparent discrepancies as to stops, 622.—Cowper, E. A., Illustration and explanation of effect of relative speed on friction, 622.—Hall, W. S., Effect of skidding on tyres, 624.—Yeomans, D. M., Corrections with respect to trials of vacuum and Westinghouse brakes, 624; experiment to prove whether blocks were dragging, 625; meaning of vacuum brakes being "half on" and "full on," 625.—Paget, A., Question is one of ascertaining facts, not of particular brakes, 626.—Hopkinson, J., Intervening film of air is probably partial cause of decrease of friction, 626.—McDonnell, A., Difference between dynamic and static friction, 627.—Fay, C., Early experiments with his own brake, proving evil of skidding, 628; effect of sand, and means of applying it, 629.—Marindin, F. A., Board of Trade return as to working of different brakes, 630.—Galton, D., Distance between brake-blocks and wheels in vacuum train, 630; explanation as to vacuum brake being "full on" or "half on," 631.—Robinson, J., Aid rendered by Mr. Westinghouse in these experiments, 631; difficulty of arriving at general agreement on best form of brake, 632.

**BRAKES, *Third Paper*** on the Effect of Brakes upon railway trains, by Douglas Galton, 1879, 170.—Effect of skidding, 170.—Coefficient of friction as affected by speed, 171.—Ditto as affected by time, 171.—Ditto as affected by material and weather, 173.—Experiments on a train cannot be free from disturbing elements, 173.—Adhesion as affecting the maximum retardation, 174.—Regulator for brake-block pressure, 175.—Experiments made with ditto, 178.—Regulation of pressure necessary for a perfect brake, 181.—Momentum of wheels due to rotation, 182.—Relation between retardation applied and weight of train, 182.—Requirements of a perfect brake, 185.—List of particulars required in order to compare different brakes, 191.

*Discussion.*—Galton, D., Reason why coefficient of friction becomes less as speed becomes greater, 194; reason why a skidded wheel has less retarding force than a wheel revolving, 194.—Yeomans, D. M., If application of brakes was instantaneous, there should be no breaking of draw-bars, 196; leather sack very durable, 196.—Marié, G., Reason why draw-bars were often broken on Lyons railway is arrangement of springs, 196.—Banderali, D., Leather sack better than india-rubber, but not perfect, 197; separate frame for block-hangers on Northern railway, 198; broken draw-bars got rid of by use of continuous draw-bars, 198.—Kennedy, A. B. W., Connection of friction with velocity and with time, 199; friction seems to tend to a constant quantity, 200; relation between friction and pressure per square inch, 200.—Marié, G., With elastic brakes no disadvantage in suspending block-hangers direct from carriage, 202.—Paget, A., Statical friction much greater than dynamical in case of ropes passing round grooved wheels, 203; diminution of friction with time might be due to change in material, caused by heat, 204.—Riches, T. H., Working of Smith vacuum brake on Taff Vale railway, 204.—Sanders, R. D., Cause of reduced friction with skidded wheel is hardness of surfaces in contact, 204; essential that brake should indicate when it is out of order, 205; no obstruction should be allowed in continuous pipe, 206; whole apparatus should form one chamber, 207.—Haskins, J. F., Eames brake worked successfully on elevated railways in New York, 208.—Tyler, Sir H., Satisfactory to see foreign gentlemen present, 208.—Williams, R. P., Experiments on coefficient of friction agree with results obtained by Poirée, 208; Table showing best results that could be obtained theoretically, 210.—Cowper, E. A., Tendency in carriage to dip down in front is caused by centre of gravity being above rails, 211; burnishing of rubbing surfaces causes loss of adhesion during skidding, 212.—Parsons, Hon. R. C., Diminution of friction due to film of dust, 212.—Hawksley, C., Arrangements for preventing skidding might still be improved, 213.—Marié, G., Heat is main cause of diminution in friction,

## BRAKES (continued).

213.—Westinghouse, G., Jun., Diminution in friction is due to abraded metal acting as little rollers, 213; effects and advantages of friction-regulating valve, 214.—Firth, S., Automatic brake should be applied in cases of emergency only, 215.—Riches, T. H., Were Capt. Galton's results obtained upon steel or iron rails, 215.—Galton, D., After certain time, friction would probably become uniform, 215; diminution of friction with time is due to heat generated, 216; no higher brake-pressure should be applied than required for any particular speed, 216; experiments all made on steel rails, 217.—Robinson, J., Desirable to have paper on the vacuum brake, 217.

BRAKES, Is Automatic action necessary or desirable in a continuous railway Brake? *Paper* by T. H. Riches, 1880, 100.—Essential points on which decision should be based, 100.—Comparison between beneficial results and defects of automatic action, 101.—Severance of trains, 101.—Couplings should have increased strength, 102.—Automatic brake has twice as many parts as non-automatic, 102.—Automatic brakes liable to creep on, 103.—Difficult to regulate down long inclines, 103.—Comparison of automatic and non-automatic brakes, from Board of Trade returns, 104.—Failures through different causes classified, 104.—Not yet any automatic brake sufficiently simple and reliable, 105.—Tables showing working of automatic and non-automatic brakes, 107–112.

*Discussion.*—Sanders, R. D., Record of failures should include cases where brake failed to apply itself when wanted, 113; brakes required by Board of Trade to be instantaneously self-acting, 113; importance of tell-tale action in brakes, 114; only one instance of his own brake refusing to go on, 114; instances showing value of automatic action, 114; relative number of parts in automatic brake and in non-automatic, 115; nicety of regulation in automatic brake for descending inclines, 115; advantage of self-application in automatic brake, 116; no instance of his own brake creeping on, 117.—Gutch, G. A., Question should be treated independently of individual brakes, 117; comparison should give number of failures which would affect efficiency, 119; brakes to be self-acting in every case, not merely in case of severance, 119; breakages of couplings are reported only when resulting in accidents, 120; action of automatic brake in Bickley accident, 121; increased strength of couplings would not prevent parting of trains, 122; self-application of automatic brake when out of order is not a failure but a success, 122; trifling nature of many reported failures of automatic brake, 123; dangerous failures of vacuum brake, 123; comparison of Vacuum and Westinghouse brakes on North Eastern Railway, 124; Westinghouse brake does not creep on, 125; negligence is sole cause of brakes refusing to come off, 126; working of automatic brakes down long

## BRAKES (continued).

inclines, 126; report of M. Marié as to brakes on steep gradients, and as to automaticity, 127; similarity between automatic brakes and block system of signalling, 128.—Tyler, Sir H., Automatic principle essential for continuous brakes, 128; analysis of seven years' accidents, with Table, 130; principle of tell-tale action, 131; breakage of couplings, 132; reports should discriminate between failures leading to danger, and virtual successes, 132.—Williams, R. Price, Difficulty as to mode of tabulating the failures, 133.—Banderali, D., Objection to automatic action without block signalling, 134; brake should only give warning of defect, instead of stopping the train, 134.—McDonnell, A., Question whether automatic action is not obtained at too great cost, 134; difficulty of rating the value of brakes by their failures, 135; brake power should be limited for ordinary stoppages, reserving full power for emergencies, 136.—Tomlinson, J., Satisfactory use of Smith brake on Metropolitan Railway, 136.—Yeomans, D. M., Value of Smith brake, and importance of half-yearly returns, 136.—Westinghouse, G., Way of arranging failures in Tables, 137; experience with Westinghouse brake on Brighton Railway, 137; automatic brake now superseding non-automatic in United States, 138; desirability of devising tell-tale to act without applying the brake, 139.—Fairholme, Capt. C., Working of Heberlein automatic brake on Maenclochog Railway in South Wales, and in Germany, 139.—Riches, T. H., No objection to automatic action in itself, 139; difference in importance of failures with non-automatic and automatic brakes, 140; automatic brake not a perfect tell-tale, 140; separation of pipe-couplings in Smith brake not important, 141; method of counting number of separate parts in brakes, 141; relative merit of automatic and non-automatic brakes for working down inclines, 142; comparison need not include merely sectional brakes, 142; comparison from number of failures is not incorrect, 143; intention of Board of Trade requirements as to automatic action, 144; accidents from broken couplings, 144; desirability of increased strength of couplings, 145; interpretation of failures on different railways, 145; serious nature of repairs needed for automatic brakes in comparison with non-automatic, 146; relative merits of brakes should be estimated upon mileage run, 147; creeping on of brakes is caused by leakage, 147; refusal of brakes to release when required, 148; successful working on steep gradients with Smith brake, 148; small percentage of accidents calling for automatic action, 149; mode of analysing recorded failures in Tables, 149.—Robinson, J., Present paper prepared by the author at request of the Council, 150.—Cowper, E. A., Returns fairly analysed by the author, 150; failures should be analysed by Board of Trade as to character, 150.

**BRAKES**, *Paper* on recent Brake experiments upon the Lyons railway, by G. Marié, 1879, 157.—Particulars of apparatus, 157.—Practical working of the two brakes tried, 160.—Results of the experiments made, 161.—Comparison of the retarding forces in different stops, 165.—General conclusions, 167.

**BRAKES**, Friction. *See* Dynamometers. 1876, 199.

**BRAKES**, Lartigue, Delebecque and Banderali's automatic electrical apparatus for railway brakes, 1878, 554.

**BRAMWELL**, SIR F. J., elected President, 1874, 26.—1875, 34.

Address, Presidential, 1874, 103.

Bath, Floating Swimming, 1875, 154, 159, 160.

Boiler and Engine, High-Pressure, 1877, 155.

Bridge, Erection of, over river Dal, 1876, 55.

Cement, Portland, 1875, 59, 61.

Chuck, Electro-Magnetic, 1875, 44, 45.

Compressed-Air Machinery, 1874, 220, 222, 224, 225, 230.

Condenser, McCarter, 1876, 312, 316.

Dock, Victoria Floating, 1878, 175, 179, 182.

Docks, Pumping Machinery, 1874, 159, 161.

Docks, Cardiff, 1874, 140, 144.

Dynamometers, 1876, 227, 242.

Engines, Pumping, Direct-Acting, 1874, 279

Engines, Winding, Direct-Acting, 1875, 245.

Fairbairn, Sir W., deceased, Notice of, 1874, 253.

Fire-Feeder, Frisbie Mechanical, 1876, 323.

Gas-Engine, Atmospheric, 1875, 215.

Gauge, Railway, 1875, 77, 79.

High-Pressure Vessels, 1878, 278.

Hydraulic Machinery, Packing for, 1874, 140.

Hydraulic Machinery, Workshop, 1874, 184, 201.

Lloyd, Sampson, deceased, Notice of, 1874, 253, 254.

Marine Engine, 1881, 486.

Patent Laws, 1875, 163, 186.

Power Transmission by Ropes, 1874, 67, 72, 75.

Puddling, Mechanical, 1876, 279.

Pump, Helical, 1874, 295.

Rock-Drill, Diamond, 1875, 124.

Rock-Drilling Machinery, 1874, 96, 99.

Rules, 1875, 37.—1876, 30.—1877, 32.

Saw, Direct-Acting Circular, 1875, 131, 133.

Secretary, Vote to late, 1878, 110, 112.—Appointment, 1884, 78.

Steel Boiler Experiments, 1878, 236.



BRAMWELL, SIR F. J. (continued).

Steel, Hardening, &c., of Steel, 1883, 68.

Steel, Tempered, Molecular Rigidity of, 1883, 90, 91.

Votes of thanks to President for Address, 1881, 424.

Wood-Working Machinery, 1875, 261, 265, 267.

BRIDGE, ERECTION OF, *Paper* on the mode of Erection of the large Iron Girder Bridge over the river Dal in Sweden, by Edward Hutchinson, 1876, 46.—Site of bridge, 46.—Girders, 46.—Adjusting apparatus, 47.—Test of iron for girders, 47.—Difficulty of fixing girders, from character of river, 48.—Different plans of erection proposed, 49.—Details of plan adopted, 49.—Counterweight, 50.—Derrick cranes preferable to portable cranes in the erection, 51.—Sectional area of main girders, 52.—Calculation of counter-balance weight, 52.—Cost of erection, 53.

*Discussion.*—Lloyd, S. Z., Additional strength required in lower flanges of girders during erection, 53.—Head, J., Top and bottom sections are of equal strength, 53.—Cowper, E. A., Girders able to carry their own weight during erection, 54.—Hawksley, T., Reports on similar bridges in America, 54.—Galton, Capt. D., Comparative cost of erection, 54; strain put upon girders in erection, 54.—Bramwell, F. J., Specimen arch built in cement by Brunel at Thames tunnel, 55.

BRICKNELL, A. L., elected Member, 1883, 179.

BRIGGS, J. H., elected Member, 1881, 624.

BRIGGS, R., elected Member, 1881, 624.—Decease, 1883, 36.—Memoir, 11.

BRIGHT, T. S., elected Graduate, 1880, 310.

BROAD, R., decease, 1875, 3.—Memoir, 19.

BROADBENT, T., elected Member, 1875, 189.—Decease, 1881, 11.—Memoir, 2.

BROAD GAUGE. *See* Gauge, Railway, 1875, 66.

BRODIE, J. S., elected Member, 1879, 397.

Traction Engines in India, 1879, 517.

BROMLEY, M., elected Member, 1877, 165.—Memoir, 1884, 400.

Iron and Steel for Boilers, 1879, 320.

BROOKE, A., elected Graduate, 1878, 31.

BROPHY, M. M., elected Member, 1880, 9.

BROTHERHOOD, P., elected Member, 1874, 101.

Compressed-Air Machinery, 1874, 224, 225.

Dynamometer, Marine-engine, 1877, 263.

Hydraulic Machinery, Workshop, 1874, 183, 184.

Pump, Helical, 1874, 294.

Saw, Direct-Acting Circular, 1875, 130.

BROTHERHOOD'S Three-cylinder Hydraulic Engine, 1874, 173.—Ditto, Compressed-Air, for propelling torpedo, 1874, 224.—Ditto, Steam, for driving direct-acting circular saw, 1875, 130.

BROWN, A., Dredger, Vertical-action, 1879, 557.

BROWN, A. B., Hydraulic Machinery, Marine, *Paper* on Hydraulic Machinery for steering, reversing, and discharging cargo &c., in steamships, 1874, 33.—Remarks, 44, 45, 50, 51, 52, 54.

Rules, 1874, 30.

BROWN, C., elected Member, 1879, 37.

Brakes, Effect of, upon railway trains, 1878, 484.

Tramways, Mechanical Traction, 1878, 423.

BROWN, F. R. F., elected Member, 1880, 185.

BROWN, G. W., elected Member, 1881, 408.

BROWN, O., elected Member, 1884, 79.

BROWN'S PORTABLE STEAM DRILL, 1878, 573.

BROWN'S TRAMWAY LOCOMOTIVE, 1880, 44. *See* Locomotive, Brown's Tramway.

BROWNE, B. C., Locomotive, *Paper* on Brown's Tramway Locomotive, 1880, 44.—Remarks, 57, 59, 76–81.

Mining Machinery, 1882, 380.

Traction Engines in India, 1879, 525.

BROWNE, C. O., Armour, *Paper* on the construction of Armour to resist shot and shell, 1879, 52.—Remarks, 69, 73, 78, 82.

BROWNE, T. R., elected Graduate, 1874, 55.

BROWNE, W. R., elected Secretary, 1878, 29.—Resignation of post of Secretary, 1884, 25.—Memoir, 472.

Brakes, *Supplementary Paper* on the Theory of the action of Brakes upon the wheels of a train, 1878, 617.

Power Transmission by Ropes, 1874, 68.

Tynewydd Colliery Inundation, 1877, 229.

BRUCE, G. B., elected Member, 1874, 55.

BRUNTON, J. D., Stone-Dressing Machinery, *Paper* on Stone-Dressing Machinery, 1881, 133.—Remarks, 141, 143, 144.

BRYAN, W. B., elected Member, 1884, 198.

BRYHAM, W., Engines, Winding, Direct-Acting, 1875, 242.

BUCKLE, W. H. R., elected Graduate, 1880, 186.

BUCKLEY, R. B., Dredger, *Paper* on the construction and working of a Vertical-action Steam Dredger in India, 1879, 534.—Remarks 554, 559.

Traction Engines in India, 1879, 518.

BUCKLEY, S., elected Member, 1877, 71.

BUCKTON'S FLANGE-DRILLING MACHINE, 1878, 568, 576.—Buckton and Wicksteed's Multiple Drill, 566, 575, 578.

BUDDICOM, H. W., elected Graduate, 1878, 108.

BUDDICOM, W. B., elected Member, 1874, 101.

BUDGE, E., elected Member, 1882, 15.

BULKLEY, H. W., elected Member, 1881, 624.

- BULLOCK, J. H., elected Member, 1884, 408.  
 BULL ENGINE. *See* Engines, Pumping, Direct-Acting, 1874, 259.  
 BULMER, J., elected Member, 1882, 254.  
 BUNNING, C. Z., elected Member, 1884, 79.  
 BUNT, T., elected Member, 1884, 198.  
 BUNTING, G. A., elected Member, 1884, 408.  
 BURGESS, J. F., elected Member, 1877, 299.  
 BURGH, N. P., not a member of the Institution, 1880, 311.  
 BURN, R. S., elected Member, 1881, 624.  
 BURN, W. E., elected Member, 1874, 101.  
 BURNET, L., elected Graduate, 1879, 398.  
 BURNETT, R. H., elected Member, 1878, 558.  
 BURRELL, C., JUN., elected Member, 1878, 558.  
 BURTON, C., elected Member, 1877, 71.  
 BURY, W. T., decease, 1877, 2.—Memoir, 17.  
 BUTCHER, J. J., elected Member, 1884, 198.  
 BUTE DOCKS, description. *See* Docks, Cardiff, 1874, 119.—1884, 227.  
 BUTE GAS WORKS, Cardiff, 1884, 366.  
 BUTE SHIPBUILDING AND ENGINEERING WORKS AND DRY DOCK, Cardiff, 1884, 238, 360.  
 BUTLER, A. E., decease, 1884, 3.—Memoir, 61.  
 BUTLER, E., elected Member, 1882, 254.  
 BUTLER, H. M., elected Graduate, 1884, 409.  
 BUTLER, T. S., decease, 1875, 3.—Memoir, 19.  
 BYE-LAWS. *See* Rules.

## C.

- CABRY, T., decease, 1874, 2.—Memoir, 16.  
 CAIRNS, Hon. H. J., elected Graduate, 1883, 594.  
 CAMBRIAN FOUNDRY AND ENGINEERING WORKS, Newport, 1884, 394.  
 CAMMELL, C., decease, 1880, 10.—Memoir, 1.  
 CAMPBELL, A., elected Member, 1877, 165.  
 CAMPBELL, DANIEL, elected Member, 1880, 310.  
 CAMPBELL, DAVID, decease, 1883, 36.—Memoir, 15.  
     Hydraulic Machinery, Workshop, 1874, 194.  
 CAMPBELL, JAMES, Locomotives, Franco's Fireless, for Tramways, 1879, 627, 638.  
 CAMPBELL, JOHN, elected Member, 1882, 254.  
 CAMPIN, F. W., Patent Laws, 1875, 172, 173, 184.  
 CAMPOS, R. M., elected Member, 1882, 145.  
 CANAL BOATS, Towing by Endless Rope, 1874, 72.  
 CANDLIN, C., elected Member, 1875, 314.

- CANNOCK CHASE COALFIELD, means of boring through pebble beds, 1875, 111, 116.
- CAPACITY OF BLAST FURNACES. *See* Blast Furnace Capacity, 1875, 334.
- CARBON IN STEEL, 1883, 56. *See* Steel, Hardening, &c.
- CARBUTT, E. H., elected Member of Council, 1875, 34.
- Address of President, 1884, 224.
  - Council, Annual Report, 1884, 20.
  - Dynamometers, 1876, 234.
  - Gas Engine, Atmospheric, 1875, 207.
  - Locomotive Running Shed, 1884, 251.
  - Portable Railways, 1884, 143.
  - Pressure-Intensifying Apparatus, 1878, 63.
  - Puddling, Mechanical, 1876, 272, 279.
  - Rules, 1877, 26.
  - Secretary, appointment, 1884, 77, 78.
  - Ventilators for Mines, Mechanical, 1875, 326.
  - Ventilator, Roots' Mine, *Paper* on Roots' Mine Ventilator, and other applications of Roots' blower, 1877, 92.
  - Vote of thanks to retiring President, 1878, 33.
- CARDEW, C. E., elected Member, 1878, 30.
- Petroleum Fuel in Locomotives, 1884, 315.
- CARDIFF DOCKS, *Papers* on, 1874, 119.—1884, 227. *See* Docks, Cardiff. Visited at Cardiff meeting, 1874, 144.—1884, 356.
- CARDIFF GAS LIGHT AND COKE WORKS, 1884, 366.
- CARDIFF JUNCTION GRAVING DOCK, 1884, 236.
- CARDIFF ROPE WORKS, 1884, 365.
- CARDIFF SUMMER MEETING, 1884, 197.—Reception, 197.—Business, 198.—Votes of thanks, 200.—Excursions &c., 356.
- CARDIFF WORKS, visited at Summer meeting, 1884, 357, 360.
- CARDOZO, F. C. DE M., elected Member, 1875, 189.
- CARELS' ENGINE WORKS, visited at Summer meeting, Belgium, 1883, 517.—Description of Works, 568.
- CARLTON, T. W., elected Member, 1878, 31.
- CARPMAN, W., Patent Laws, 1875, 170, 182.
- Steel, Fluid-Compressed, and Guns, 1875, 291.
- CARR, R., elected Member, 1877, 71.
- CARR, T., decease, 1875, 3.—Memoir, 19.
- CARRICK, H., elected Member, 1884, 79.
- CARRINGTON, W. T. H., elected Member, 1874, 256.
- CARSON, W., elected Member, 1876, 27.
- CARTER, C., elected Member, 1877, 71.
- CARTER, W., elected Member, 1877, 165.

CASE-HARDENED IRON RAILS, 1876, 255.

CASTLE PIT, Troedyrhiew, Crawshay's, large pumping and winding engines, 1874, 238.

CAST-STEEL INGOTS, Compressed by Steam Pressure. *See* Steel Compression by Steam, 1880, 396. Structure of Cast-Steel Ingots, 1880, 152. *See* Steel, Chernoff's Papers.

CAWLEY, G., elected Member, 1883, 179.

CEMENT, PORTLAND, *Paper* on the Manufacture and Testing of Portland Cement, and the machinery used in its production, by H. Faija, 1875, 46.—Composition of cement, 46.—Machinery and process of manufacture, 47.—Quality of cement, tests, weight and fineness, 53.—Tensile strength, 54.—Expansion, 54.

*Discussion.* Faija, H., Specimens exhibited, 55; deficiency of strength in coarse cement, 56.—Cowper, E. A., Description of Hoffmann's kiln, 56; dry process of manufacturing cement, 57; testing for tensile strength, 58.—Siemens, C. W., Continuous kiln worked with gas, 59; position of fracture in testing briquettes, 59.—Faija, H., Size of backs, 60; testing for tensile strength, 60; quick setting cement, 60.—Bramwell, F. J., Process of manufacture, 61; comparison of tensile and compression tests, 62; utilising waste heat from kiln, 62.

CENTRIFUGAL PUMP, 1874, 149, 293.

CENTRIFUGAL SEPARATOR, *Paper* on a Centrifugal Separator for Liquids of different specific gravities, by W. Bergh, 1882, 519.—Description of machine, 519.—Construction of rotating vessel, 520.—Frictional driving gear, 520.—Lubrication of bearings, 521.—Previous machines, 521.—Other applications, 522.

*Discussion.*—Bergh, W., Experiments in purifying tar, 523.—West, J., Separation of tar and ammoniacal liquor, 523; condensation of tar &c. from crude gas, 524.—Anderson, W., Action of separator at Royal Agricultural Society's show, 524.—Davey, H., Separation of metallic particles in slimes at metal mines, 525.—Bergh, W., Separation of tar, 526; purification of milk, 527.—Ramsbottom, J., Machine capable of wide application, 527.

CERTIFICATES of Membership in Institution, 1878, 43, 114, 562.

CHAIN BRAKE for Railway Trains, 1878, 69, 71, 98. *See* Brakes.

CHALK, Water Supply from, 1876, 163. *See* Water Supply from Chalk.

CHALLEN, S. W., elected Member, 1876, 347.

CHAMBERLAIN, J., elected Member, 1884, 198.

CHANNEY, H. J., Water Meters, 1882, 79.

CHANNEL TUNNEL, 1882, 440. *See* Tunnel, Channel.

CHANTILLY FOREST, Visit to, 1878, 555.

CHAPMAN, HEDLEY, elected Member, 1882, 254.



- CHAPMAN, HENRY, elected Member of Council, 1878, 29.—Honorary Local Secretary for Paris meeting, 1878, 300.  
 Boiler and Engine, High-Pressure, 1877, 132.  
 Compressed-Air Machinery, 1874, 223.  
 Filter, *Paper* on the Farquhar Filtering apparatus, 1881, 145.  
 Hydraulic Machinery, Workshop, 1874, 181.  
 Rules, 1884, 27.  
 Secretary, Vote to late, 1878, 28.  
 Traction Engines in India, 1879, 530.  
 Valves, Safety, 1877, 185.
- CHAPMAN, J. G., elected Member, 1878, 107.  
 Presses, Hydraulic Packing, 1877, 371.
- CHAPÉ DE LEONVAL, T. F., elected Member, 1878, 293.
- CHATER, J., elected Member, 1877, 299.
- CHATHAM DRY DOCKS. *See* Dock Pumping Machinery, 1874, 145.
- CHECKLEY, T., decease, 1881, 11.—Mémorial, 2.
- CHENEUX, L., Description of Blast Furnaces and Collieries at Ougrée, 1883, 538.
- CHERNOFF, D., Steel, *Paper* (1868) on the Manufacture of Steel, and the mode of working it, translated by W. Anderson, 1880, 286. — *Paper* (1878) on the Structure of Cast-Steel Ingots, translated by W. Anderson, 1880, 152.
- CHERNOFF'S PAPERS ON STEEL, Remarks on, *Paper* by W. Anderson, 1880, 225.  
*See* Steel.
- CHILCOTT, W. W., elected Member, 1881, 163.
- CHILDE, R., elected Member, 1883, 179.
- CHISHOLM, J., elected Member, 1877, 71.
- CHOCOLATE WORKS, Menier's, at Noisiel, visit to, 1878, 550.
- CHUCK, ELECTRO-MAGNETIC, *Paper* on Jaques Oakley and Sterne's Electro-Magnetic Chuck for holding special work in lathes, &c., by W. E. Newton, 1875, 38.—Construction of chuck, 38.—Grinding thin steel discs, 39.—Application to bed of planing machine, 40.  
*Discussion.* Smith, W., Magnetic chuck probably not suitable for parts of delicate instruments, 41.—Siemens, C. W., Electric connection from battery by number of touching points, 41; force of attraction of electro-magnets, 41.—Robinson, J., Centering and bevelling edge of discs, 42.—Cowper, E. A., Electric connection by brush of wires, 43.—Smith, W., Amount of adhesion attainable, 43.—Paget, A., Thin discs liable to spring when warped, 43.—Siemens, C. W., Force of attraction of electro-magnet, 44.
- CHURCH, C. S., elected Member, 1882, 15.
- CHURCHWARD, G. D., elected Member, 1880, 310.
- CIRCULAR SAW, Direct-Acting. *See* Saw, Direct-Acting Circular, 1875, 126.

- CIRCULAR SLIDE VALVE. *See* Valve, Circular Slide, 1877, 197.
- CLANNY SAFETY LAMP, 1879, 221. *See* Safety Lamps.
- CLAPHAM, R. C., decease, 1882, 17.—Memoir, 2.
- CLARIDGE, T., Engines, Winding, Direct-Acting, 1875, 241.
- CLARK, D. K., elected Member, 1878, 558.
- CLARK, J., decease, 1877, 2.—Memoir, 18.
- CLARK, T., decease, 1874, 2.—Memoir, 17.
- CLARK, W., decease, 1881, 11.—Memoir, 3.
- CLARK, W. J., Shafting, Strength of, 1883, 185.
- CLAUSIUS, R., Note as to Theoretical Loss in Expanding Steam before admission, 1880, 42.
- CLAUZEL, Baron G., Riveting, *Paper* on Riveting, with special reference to Ship-Work, 1881, 167.
- CLAY, W., elected Member of Council, 1874, 26.—Decease, 1882, 17.—Memoir, 3.  
Rope Gearing, 1876, 390.  
Water Supply from Chalk, 1876, 170.
- CLAYTON, C., elected Member, 1875, 314.
- CLAYTON, T. G., South-Wales Mineral Wagons, 1884, 430.
- CLAYTON, W. W., elected Member, 1882, 254.
- CLENCH, F. McD., elected Graduate, 1883, 310.
- CLENCH, G. McD., elected Graduate, 1881, 409.
- CLERK, F. N., decease, 1875, 3.—Memoir, 20.
- CLEWORTH, C., decease, 1876, 2.—Memoir, 18.
- CLIFT, J. E., decease, 1876, 2.—Memoir, 18.
- CLINKSKILL, A. A. R., elected Graduate, 1883, 594.
- CLOSSON, J. B. P., elected Member, 1878, 558.—Decease, 1884, 3.—Memoir, 62.  
Disintegrator, *Paper* on the Vapart Disintegrator, 1878, 490.—Remarks, 502.
- CLOWES, E. A., elected Associate, 1879, 38.
- COAL AND IRON INDUSTRIES in Liège District, 1883, 329. *See* Liège Iron and Coal Industries.
- COAL, Economy in use, 1874, 112.—Breakage in loading ships, means of prevention, 128, 134, 135, 136.—Pulverised state more efficient, 137.—Results of trials, 141.—Shipping machinery, 119.—Tips for discharging wagons, 125, 127.
- COALING CRADLE, Westmacott's, 1884, 229.
- COAL MINES, Electricity for Working. *See* Electricity for Coal Mining, 1883, 421.
- COAL-SHIPPING MACHINERY at Bute Docks, Cardiff, 1874, 119.—1884, 227. *See* Docks, Cardiff.
- COATES, J., elected Member, 1882, 254.
- COATH, D. D., elected Member, 1883, 33.
- COCHRANE, B., elected Member, 1881, 409.

- COCHRANE, C., elected Member of Council, 1874, 26.—1877, 25.—Vice-President, 1878, 29.—1881, 30.—1884, 21.
- Blast-Furnace Capacity, *Paper* on the Ultimate Capacity of Blast-Furnaces, 1875, 334.—Remarks, 357.—Further do., 1876, 35.
- Blast-Furnace Working, *Paper* on the Working of Blast-Furnaces of large size, at high temperatures of blast, with special reference to the Position of the Tuyeres, 1882, 279.—Remarks, 298, 304, 314.
- Blast-Furnace Working, *Paper* on the Working of Blast-Furnaces, with special reference to the Analysis of the Escaping Gases, 1883, 93.—Remarks, 135, 141, 152.
- Boiler and Engine, High-Pressure, 1877, 140.
- Boiler Feeder, Fromentin Automatic, 1882, 494, 498.
- Boiler, Lancashire, 1876, 108.
- Brakes, Effect of, upon railway trains, 1878, 485.
- Cement, Portland, 1875, 59.
- Coke Manufacture, 1883, 288.
- Compressed-Air Machinery, 1874, 217, 220.
- Condenser, McCarter, 1876, 310.
- Cultivation by Horses, 1880, 550.
- Disintegrator, Vapart, 1878, 502.
- Diving Appliances, 1882, 191, 197.
- Electricity for Coal Mining, 1883, 434.
- Engines, Winding, Direct-Acting, 1875, 238.
- Feed-Water Heater and Filter, 1881, 549.
- Friction Experiments, 1884, 35.
- Gas Engine, Atmospheric, 1875, 211.
- Injector, Automatic, 1884, 178, 186, 187.
- Iron and Steel for Boilers, 1879, 315.
- Iron and Steel, Physical condition of, 1884, 60.
- Jute Machinery, 1880, 392.
- Liège Iron and Coal Industries, 1883, 311.
- Locomotive, Brown's Tramway, 1880, 75.
- Mines, Furness Iron, 1880, 372.
- Nottingham meeting, introductory remarks, 1884, 407.—Reply to Mayor's welcome, 408.—Remarks on business of Institution, 408-413.
- Portable Railways, 1884, 145.
- Puddling, Mechanical, 1876, 275.
- Railway Electric Signals, 1884, 471.
- Rock-Drill, Diamond, 1875, 111.
- Rules, 1874, 32.—1876, 31, 349.—1877, 26.—1880, 34, 36.—1884, 26.
- Secretary, appointment, 1884, 78.
- South-Wales Mineral Wagons, 1884, 441, 442, 443.

## COCHRANE, C. (continued).

Steel, Fluid-Compressed, and Guns, 1875, 239.

Steel Plant, Bessemer, 1881, 640.

Testing Machine, Single-Lever, 1882, 391.

Tuyere, Open Spray, 1876, 359.

Ventilator, Roots' Mine, 1877, 107.

Vote of thanks to Institution of Civil Engineers, 1884, 27.

Water Pressure Regulators, 1879, 438.

Zinc Manufacture in Belgium, 1883, 367.

COCKERILL, Works of the Society Cockerill, visited at Summer Meeting, Belgium, 1883, 511, 516.—Description of Works, 519.—Collieries, 528.

COE, W. J., elected Member, 1876, 27.

COGGER, J., Water Meters, 1882, 96.

COKE, *Paper* on Improvements in the Manufacture of Coke, by J. Jameson, 1883, 275.—Distillation of coal yields products not originally contained in coal, 276.—Quick distillation with extreme heat, and slow distillation at lower heat, 276.—Increased production of condensable matters from coal, 278.—Relative heating power of gas and of carbon, 280.—Four methods of distilling coal, 281.—Explanation of improved method, 282.—Description of ovens, 284.—Value of products obtained in condenser, 286.

*Discussion.*—Cochrane, C., Leakage of air into bee-hive coke-ovens, 288 ; economy of warming the air before admission, 288 ; higher temperature increases hardness of coke, 289 ; no saving in yield of coke from new oven, 289 ; value of gas depends on demand for it, 290 ; difficulty of maintaining the distillation, 290 ; actual value of products not so high as hoped for, 290.—Samuelson, B., Carvès process gives dense coke with large saving in yield, 292 ; saving of by-products will diminish their value, 293.—Bauerman, H., Advantage of new process as to condensable products, but disadvantage as to coke, 294 ; use of Coppée and of Otto oven, 295.—Nichol, B. G., Successful results of process at Page Bank, 295 ; ditto at Felling, 296 ; explanations of difference, 297.—Cowper, E. A., Economy of burning part of gas to heat oven, 298 ; distillation at low temperature yields poor coke, 299 ; heating of air in Brodie Cochrane oven, to produce intense combustion of gas, 299.—Jameson, J., No difference in appearance from ordinary coke, 300 ; expediency of burning gas or coke to heat oven, 300 ; value of products, 301 ; quantity of products from different coals, 301 ; tables of results of experiments and analyses, 302 ; relative advantage of Simon-Carvès process, 304 ; new process does not take away the pitch, 304 ; large admission of air necessary to get the heat required, 304 ; mode of sealing the oven bottom, 305.—Westmacott, P. G. B., Samples of coke to be sent for examination, 305.

COKE OVENS, Brodie Cochrane, 1883, 299; Coppée, 295; Jameson, 284; Otto, 295; Simon-Carvès, 291. *See* Coke.

COLD AIR, *Paper on Machines for producing Cold Air*, by T. B. Lightfoot, 1881, 105.—Cooling of air by successive compression, cooling, and expansion, 105.—Deposition of contained moisture, 107.—Previous machines for producing cold air, 109.—Kirk's, 109.—Giffard's, 110.—Windhausen's, 110.—Bell-Coleman refrigerator, 111.—Sturgeon's, 113.—Hick Hargreaves and Co.'s, 113.—Hall's modified Giffard machine, 114.—Test experiments, 115.—Hall's smaller machine, 115.—Dry-air process with double expansion, 116.—Hall's dry cold-air machine with double expansion, 118.—Application of cold-air machines, 120.—Table of air saturation, 122.—Table of adiabatic compression or expansion of air, 123.—Table of cattle and sheep in Australasia, 124.

*Discussion.*—Lightfoot, T. B., Results of working of vertical dry-air machine, 125; system applicable to compressed-air engines, 125.—Schönheyder, W., Rapid compression not essential to generate heat, 125; experiments on early Giffard refrigerator, 125, 126; objection to air pressure behind piston packing, 126; amount of heat carried off by the cooling water, 127; system shown not economical, 127.—Gorman, W. A., Relative performance of ether and moist-air machines in making ice, 127.—Kirk, A. C., Success of moist-air and dry-air machines, 128.—Crampton, T. R., Consumption of coal depends on kind of engines used, 128.—Joy, D., Distinction between engines for cooling air and for making ice, 128.—Gray, J. McF., Importance of simplicity and compactness on board ship, 128; diagrams should show zero line of pressure, 129.—Williams, R. Price, Value of refrigerators for importation of food supply, 129.—Cowper, E. A., Advantage of drying air by preliminary expansion, 130.—Schönheyder, W., Comparison between production of ice and of cold air in Siddeley machine, 130.—Lightfoot, T. B., Heat carried off by the cooling water must fall short of that expended in compression, 131; cold-air machines not intended for making ice, 131.—Cowper, E. A., Why is ice objectionable in cold-air machines, 132.—Lightfoot, T. B., Only from freezing up of passages, 132.—Cowper, E. A., Increased demand for cold-air machines for preservation of meat, 132.

COLE, C., elected Member, 1884, 79.

COLE, G., Water Meters, 1882, 97.

COLE, Sir H., Patent Laws, 1876, 189.

COLE, J. W., elected Member, 1878, 31.

Stone-Dressing Machinery, 1881, 144.

COLES, H. J., elected Member, 1878, 31.

COLEY, H., elected Member, 1877, 71.



- COLLENETTE, R., elected Member, 1884, 198.
- COLLIERIES, ACCIDENTS AT. *See* Accidents, Mine, 1877, 314.—Tynewydd Colliery Inundation, 1877, 221.
- COLLIERIES, *Notes on* Collieries in neighbourhood of Liège, by E. P. Rathbone, 1883, 528.
- COLLIERIES visited at Summer meeting, Belgium; Cockerill, 1883, 522, 525, 528.  
—Hasard, 515, 531.—Horloz, 513, 530.—Mariemont and Bascoup, 517, 570.—Marihayé, 513, 530.—Ougrée, 513, 539.
- COLLIERIES visited at Summer meeting, Cardiff, 1884, 357.—Cymmer, 371.—Great Western, 369.—Lewis' Merthyr, 370.—Llwynypia, 372.
- COLLIERY, Aberaman, Aberdare Valley, Waddle ventilating fan, 1874, 235.  
Crawshay's Castle Pit, Troedyrhiew, large pumping and winding engines, 1874, 238.  
Glamorgan Coal Co., Llwynypia Colliery, Rhondda Valley, large winding engines with conical drum, 1874, 234.  
Harris' Navigation Coal Co., near Quaker's Yard, diamond rock-drilling machine, 1874, 249.  
Lye Cross, 1876, 332; strata passed through, 334; engines and pit frames, 335.  
Nixon's Merthyr Vale, 1874, 236; process of sinking, 236; iron pit-frames, and winding engines, 236.  
Nixon's Navigation, Aberdare Valley, winding engines, 1874, 235.  
Sandwell, 1876, 330; winding engines and pit frames, 331; hauling gear, 332; winding gear and cages, 1882, 377.  
Tynewydd. *See* Tynewydd Colliery Inundation, 1877, 221.  
Wearmouth, 1881, 615, 616.
- COLLIERY WINDING ENGINES. *See* Engines, Winding, Direct-Acting, 1875, 217.
- COLLINS, Hon. Lord Provost, Welcome to members at Summer meeting, Glasgow, 1879, 395.
- COLOMB, P., Armour, Construction of, 1879, 73.
- COLQUHOUN, J., elected Member, 1884, 198.  
Vote of thanks to President for Address, 1884, 224.
- COLTMAN, J. C., elected Member, 1884, 198.
- COLYER, F., elected Member, 1878, 293.  
Lifts, Hydraulic, 1882, 154.
- COMBING MACHINERY for Wool, 1882, 214. *See* Wool-Combing.
- COMPOUND ENGINES with variable expansion. *See* Expansion Gear, Correy's, 1878, 504.
- COMPOUND LOCOMOTIVES. *See* Locomotives, Compound, 1879, 328.—1883, 438.
- COMPOUND LOCOMOTIVE, WEBB'S. *See* Locomotives, Compound. *See* Locomotives, Fuel Consumption, 1884, 82.
- COMPOUND PUMPING ENGINES, 1874, 265, 271.

COMPOUND SEMI-PORTABLE ENGINE, Experiments with, 1879, 351, 352, 363.

COMPRESSED-AIR ENGINES FOR TRAMWAYS, *Paper* on Compressed-Air Engines for Tramways, by W. D. Scott-Moncrieff, 1881, 649.—Principles determining selection of motive power for tramways, 649.—Difficulties attending steam, 651.—Description of compressed-air tramcar, 652.—Construction of cylindrical air-receivers, 653.—Problem of dealing with motive power supplied from reservoir of compressed air, 654.—Automatic apparatus for expansion, 656.—Variation in dynamical duration of stroke, and application of inlet air-valve, 662.—Arrangement for extra starting power, 663.—Preliminary heating of air, 663.—Board of Trade rules for tramways, 664.

*Discussion.*—Scott-Moncrieff, W. D., Principle of discharging exhaust air at atmospheric pressure, 664.—Allan, G., Weight of vehicle, and gradient, 665.—Hughes, H., Relative economy of steam and air for tramways, 665; difficulties with steam, 666; shunting in streets, 667; working during snow, 667; strong engine and strong road required, 668; electricity as motive power for tramways, 668; desirability of superseding horse traction, 668; success of steam locomotives on Glasgow tramway, 669.—Adamson, D., Compressed-air reservoir of mild steel, 670; advantage of multiple engine, 670; testing of air reservoir, 671; Beaumont's compound compressed-air engines for high pressures, 671; advantage of superheating for air, 672; economy of horse traction, steam, and compressed air, 674.—Bergeron, C., Working of Beaumont's engine, 674.—Tomlinson, J., Trial of Beaumont's six-cylinder engine on Metropolitan Railway, 674; objection to compressed-air engine from absence of recuperative power, 675; need of high-pressures, and of heated air, 676.—Walker, B., Successful working of Kitson's steam tramway locomotive in Leeds, 676.—Lynde, J. G., Ditto at Blackburn, 676.—Scott-Moncrieff, W. D., Weight of car, and steepness of gradient, 676; weight is immaterial in combined car, 677; falls of snow, 677; air reservoirs, 677; Beaumont's compound engine, 677; practical question of heating compressed air, 678; doubtful economy of compressed air on railways, 679; practical difficulties with high-pressures, 679.

COMPRESSED-AIR ENGINES FOR TRAMWAYS. *See* also 1878, 401.

COMPRESSED-AIR ENGINES. *See* Rock-Drilling Machinery, 1874, 86. *See* Compressed-Air Machinery, 1874, 204.

COMPRESSED-AIR MACHINERY, *Paper* on Compressed-Air Machinery for Underground Haulage, by W. Daniel, 1874, 204.—Advantages of compressed air for underground work, 204.—Losses from leakage and small percentage of useful effect, 205.—Air compressors for Powell Duffryn Collieries, 205.—Fixed engine for underground haulage, 207.—Portable hauling engine, 207.—Compressed air advantageously substituted for steam, 208.—Losses attending employment of compressed air, 208.—

## COMPRESSED-AIR MACHINERY (continued).

Series of experiments, 209.—Useful effect at different pressures, 210.—Applicability of compressed air for pumping and coal cutting, 213.—Tables of results of experiments, 214.

*Discussion.*—Daniel, W., Necessity of frequent indicator diagrams to ascertain correct action of valves, 216.—Siemens, C. W., Losses attending transmission of power by compressed air, 217; mechanical imperfections in air-compressing engines, 218; loss from rise of temperature in compression of air, 218; prevention of this loss by injecting cold water into compressing cylinder to maintain uniform temperature, 219; perfect arrangement would be to inject the same heated water into expanding cylinder to restore the heat during expansion of the air, 219.—Daniel, W., Difficulty from ice in exhaust passage overcome, 220.—Firth, W., Difficulty from formation of ice, removed by enlarging ports, 220; percentage of useful effect with compressed air, 220.—Cochrane, C., Plan of preventing loss from clearance at ends of stroke in air-compressing cylinder, by supply of water, 220.—Homersham, C., Compressed air used for mixing lime and water, 221; water admitted into blowing cylinder, 221.—Walker, B., Injection of water into cylinder inconvenient, and not saving power by filling clearance space, 221; best construction of valves, 222; percentage of useful effect less with higher pressures of air, 223.—Chapman, H., Compressed-air used for coal-cutting, 223.—Brotherhood, P., Highly compressed air used in three-cylinder engine for propelling torpedo, 224.—Bramwell, F. J., Maximum pressure, 224; indicator diagrams at high speed, 225.—Cowper, E. A., Oscillations in indicator diagrams, 225; advantage of working expansively, 225; prevention of ice in exhaust passage, 226; air-compressing cylinder working with water, 226; conical valves for air-compressing cylinder, 226; special position of cranks for equalising power and resistance, 227.—Bainbridge, E., Great cost and low percentage of useful effect with compressed air, 227; advantage of compressed air for underground machinery, 228.—Crampton, T. R., Necessity for equalising top and bottom areas of valves to prevent jerk in opening, 228.—Daniel, W., Oscillation of pressure in indicator diagram caused by defect of air-valves, 229; objection to injection of water, 230.—Bramwell, F. J., Comparison of air and water for transmission of power, 230; much greater loss of power with air, 231; increase of air pressure at bottom of pit, 231; injection of water into air-compressing cylinders, 232; means of restoring to the expanding air the heat lost in compression, 232.

COMPRESSED STEEL AND GUNS, 1875, 268. *See* Steel and Guns.

COMPRESSION OF STEEL. *See* Steel Compression by Steam, 1880, 396.

COMPTON-BRACEBRIDGE, J. E., elected Graduate, 1881, 10.

CONDENSATION OF STEAM in long pipes, 1874, 270, 276, 279.

CONDENSER, McCARTER, *Paper* on the McCarter Condenser without air-pump for steam engines, by F. Preston, 1876, 299.—Principle of action, 299.—Construction, 300.—Successful application to non-condensing engines, 301.—Condenser can be worked at highest speeds of non-condensing engines, 302.—Difficulty of obtaining regularity of motion in engine with air-pump, 302.—Condenser advantageously applied to colliery winding engines, 303.—Calculation of steam expended compared with ordinary air-pump, 304.—Advantage of McCarter condenser, 307.

*Discussion.*—Preston, F., The McCarter condenser valuable for colliery and pumping engines, 308; power saved by not working air-pump, 309; steam required for auxiliary condenser, 310.—Cochrane, C., More water required than in ordinary condenser, 310.—Olrick, L., Means of working ordinary condenser with winding engines and marine engines, 311.—Siemens, C. W., Greater amount of steam required to expel water and air than with air-pump, 311.—Bramwell, F. J., Practicability of applying ordinary air-pump to winding engines and high-speed engines, 312; Morton ejector condenser preferable, 313; blow-through condenser used extensively in Scotland, 313; disadvantage in McCarter condenser, 314.—Preston, F., Advantage of McCarter condenser for winding engines, 315; advantage over ejector condenser, 316.—Bramwell, F. J., Ejector condenser with live steam worked without head of water, 316.—Preston, F., Vacuum could be made without blowing-through, 316.

CONDER, F. R., *Railway Traffic, Cost of, Paper* on the Cost of working different descriptions of Railway Traffic, 1878, 184.—Remarks, 210, 211, 213, 214.

Railway Working, Economy of, 1879, 141.

CONSTON LAKE, visited at Summer meeting, Barrow, 1880, 487.

CONSTITUTION OF THE INSTITUTION, 1878, 41.—Robinson, J., moves resolution giving power to Council to proceed to alter constitution of Institution, 41.—Cowper, E. A., The Institution will be "The Institution of Mechanical Engineers," without either "company" or "limited," 42.—Robinson, J., Board of Trade have refused a charter, 42.—Resolution carried, 43.—Robinson, J., Further announcements respecting Constitution, 114, 298, 557.

CONTINUOUS EXPANSION in Locomotives, 1879, 331; in Marine Engines, 1879, 357.

CONTINUOUS RAILWAY BRAKES. *See Brakes, Papers on*, by D. Galton, 1878, 467, 590; 1879, 170; G. Marié, 1879, 157; T. H. Riches, 1880, 100; R. D. Sanders, 1878, 67; W. P. Smith, 1882, 500.

CONVERSAZIONE at Bristol Summer meeting, 1877, 296 :—At Newcastle Summer meeting, 1881, 612 :—At Leeds Summer meeting, 1882, 451 :—At Cardiff Summer meeting, 1884, 358.

- CONYERS, W., elected Member, 1874, 55.
- COODE, SIR J., Gauge, Railway, 1875, 83.  
Power Transmission by Ropes, 1874, 74.  
Rock-Drilling Machinery, 1874, 93.
- COOKE, J., Ventilators for Mines, Mechanical, 1875, 330.
- COOKE'S VENTILATOR. *See* Ventilators for Mines, Mechanical, 1875, 317.
- COOKSON, N. C., Lead Processes, *Paper* on some recent Improvements in Lead Processes, 1881, 527.—Remarks, 537.
- COOPER, A., elected Member, 1877, 299.
- COOPER, C. F., elected Member, 1883, 33.
- COOPER, F., elected Member, 1875, 65.—Decease, 1883, 33.—Memoir, 15.
- COOPER, G., elected Member, 1877, 299.
- COOPER, W., elected Member, 1874, 27.
- COOTE, A., elected Member, 1881, 409.
- COPELAND, C. J., elected Member, 1881, 9.  
Steel Plant, *Paper* on Bessemer Steel Plant, with special reference to the Erimus Works, 1881, 627.—Remarks, 632, 646.
- COPLAND, W. R., Water Pressure Regulators, 1879, 442.
- COPPER WORKS, MORFA, Landore, calcining, smelting, and refining furnaces, and rolling mill, 1874, 244.
- CORDER, G. A., elected Member, 1884, 198.
- CORNES, C., elected Member, 1878, 31.
- CORNISH BEAM ENGINE. *See* Engines, Pumping, Direct-Acting, 1874, 258.
- CORREY EXPANSION GEAR, 1878, 504. *See* Expansion Gear, Correy.
- CORROSION IN MARINE BOILERS, 1884, 331.—Admiralty practice, 351. *See* Boiler Corrosion.
- CORRUGATING PRESS, HYDRAULIC, for sheet iron, 1874, 172. *See* Hydraulic Machinery, Workshop.
- COSSEY, T., elected Member, 1881, 409.
- COST OF RAILWAY TRAFFIC. *See* Railway Traffic, 1873, 184.—1879, 96.
- COTTON, F. M., elected Member, 1875, 314.
- COTTON, H. S., elected Graduate, 1883, 180.
- COTTON, J., elected Member, 1884, 1.
- COTTON MILLS, Ferdinand Lousbergs, visited at Ghent, 1883, 517, 534.
- COTTON PRESSES. *See* Pressure-Intensifying Apparatus, 1878, 45.
- COTTON SPINNING MACHINERY, *Paper* on recent improvements in the Machinery for Preparing and Spinning Cotton, by E. Spencer, 1880, 492.—OPENING AND CLEANING MACHINES, 492.—CARDING ENGINE, 492.—COMBING MACHINE, 493.—DRAWING FRAME, 494.—Knocking-off motion, 495.—Stop motions, 496.—Endless clearer cloth for top rollers, 497.—SLUBBING, INTERMEDIATE, AND ROVING FRAMES, 497.—Bobbin now leads in winding, instead of flyer, 498.—Improvements in flyers, 498.—Lock motion, 499.—Superior quality



## COTTON SPINNING MACHINERY (continued).

of work, 501.—Moderate speed of spindles best, 501.—Double-gear'd machines, 501.—SELF-ACTING MULE, 501.—MULE FOR MEDIUM COUNTS, 502.—Governor motion, 502.—Backing-off motion, 502.—Motion for tightening the backing-off chain, 503.—Automatic nosing motion, 506.—Nose peg, 508.—Scroll on end of winding-on drum, 508.—Mode of working, 510.—Engaging of click and click-wheel on tin-roller shaft, 511.—Middle drawing-out apparatus, 512.—Connection between back shaft and taking-in scroll shaft, 513.—Cam shaft of head stock, 513.—Speeds of shafts and spindles, 513.—Increase in production and strength of yarn, 514.—Increase in speed, belt and rope driving, 515.—Jacking motion, 515.—Roller delivery motion, 516.—MULE FOR FINEST COUNTS, 516.—Improved quadrant motion for winding, 519.—Faller-lifting motion, 520.—Unlocking of faller, 521.—Relative motions of tin roller and faller, 523.—Connection by friction cones, 523.—Change of speed by quick and slow belts, 525.—Ring spinning, 527.

Cowper, E. A., Best and latest information upon cotton spinning machinery, 528.—Spencer, E., Assistance in preparation of paper, 528.

COTTON SPINNING WORKS, De Hemptinne's, visited at Ghent, 1883, 517, 565.

COTTRILL, R. N., elected Member, 1875, 189.

## COUNCIL, MEMBERS OF:—

1874, v.—Election, 26.—Nominations for 1875, 255.

1875, v.—Election, 34.—Nominations for 1876, 313.

1876, v.—Election, 26.—Nominations for 1877, 348.

1877, v.—Election, 26.—Nominations for 1878, 300.

1878, v.—Election, 28.—Retiring List, 559.—Nominations for 1879, 559.

1879, v.—Election, 36.—Retiring List, 584.—Nominations for 1880, 585.

1880, v.—Election, 24.—Retiring List, 490.—Nominations for 1881, 490.

1881, v.—Election, 30.—Retiring List, 625.—Nominations for 1882, 625.

1882, v.—Election, 32.—Retiring List, 476.—Nominations for 1883, 477.

1883, v.—Election, 53.—Retiring List, 594.—Nominations for 1884, 594.

1884, v., 22.—Election, 21.—Retiring List, 410.—Nominations for 1885, 411.

COUNCIL, ANNUAL REPORT, 1874, 1.—Investment of funds, 1.—Number of Members &c., 2.—Deaths in 1873, 2.—Donations to Library, 2.—Papers read at the meetings, 5.—Summer meeting in Cornwall, 6.—London meeting, 6.—Proposal for extending useful action of Institution, 6.—Annual election of officers, 7.—Subjects for Papers, 7.—Abstract of receipts and expenditure, 15.

1875, 1.—Number of Members &c., 1.—Investment of funds, 2.—Deaths, 3.—Donations to Library, 4.—Papers read at the meetings, 5.—Summer meeting at Cardiff, 6.—Means for extending useful action of Institution, 7.—London meeting, two days, 7.—Premiums for Papers, 8.—Investigation

## COUNCIL, ANNUAL REPORT (continued).

fund, 8.—Index to Proceedings, 8.—Papers printed before reading, 9.—Subjects for Papers, 10.—Abstract of receipts and expenditure, 18.

1876, 1.—Number of Members, 1.—Investment of funds, 2.—Deceases of Members, 2.—Donations to Library, 3.—Papers read at meetings, 5.—Meetings in year, 6.—Subjects for Papers, 8.—Abstract of receipts and expenditure, 16.

1877, 1.—Number of Members, 1.—Investment of funds, 2.—Deceases of Members, 2.—Donations to Library, 3.—Papers read at meetings, 5.—Attendances at meetings, 6.—Subjects for Papers, 7.—Abstract of receipts and expenditure, 15.

1878, 19.—Number of Members, 19.—Removal to London, 20.—Pension to late Secretary, 20.—Financial statement, 21.—Deceases of Members, 21.—Donations to Library, 22.—Papers read at meetings, 22.—Meetings in year, 23.

*Discussion.*—Paget, A., Pension to late Secretary to be referred back to Council, 27.—Chapman, H., Seconded motion, 28.—Motion carried, 28.

1879, 21.—Number of Members, 21.—Deceases, resignations, &c., 22.—Registration of the Institution as a limited company, 23.—Receipts and expenditure, 24, 28.—Proposal to expend money on research, 25.—Proposed transfer of Institution funds from trustees, 25.—Donations to Library, 25, 30.—Papers read at meetings, 25.—Attendances at meetings, 26.

*Discussion.*—Robinson, J., Moves adoption of Report, including transfer of funds to stand in name of Institution, 34.

1880, 10.—Number of Members, 10.—Deceases, resignations, &c., 10.—Financial statement, 12, 16, 17.—Research, 12.—Donations to Library, 13, 18.—List of Papers, 13.—Attendances &c. at meetings, 14.

*Discussion.*—Robinson, J., Moves vote of thanks to Research Committees and Reporters, 23; increased number of papers, involving increased expenditure, 23.—Adamson, D., Remarks on career of late W. Howe, 23.

1881, 10.—Number of Members, 10.—Deceases, resignations, &c., 11.—Financial statement, 12, 16–17.—Research, 12.—Napier bequest and donations to Library, 13, 18–29.—List of Papers, 14.—Attendances &c. at meetings, 14.

1882, 16.—Number of Members, 16.—Deceases, resignations, &c., 17.—Financial statement, 18, 22.—Research, 19.—Donations to Library, 20, 24.—List of Papers, 20.—Attendances &c. at meetings, 21.

*Discussion.*—Cowper, E. A., Results obtained by Riveting Committee, and assistance afforded to Research Committees, 31; Newcastle meeting, 31.

1883, 35.—Number of Members, 35.—Deceases, resignations, &c., 36.—

## COUNCIL, ANNUAL REPORT (continued).

Financial statement, 37, 42, 44. — Research, 38. — Donations to Library, 39, 46. — List of Papers, 39. — Attendances at meetings, 40. — Summer meeting, 40.

1884, 2. — Number of Members, 2. — Transferences, deceases, 3. — Decease of Sir William Siemens, 3, 8. — Resignations, &c., 4. — Financial statement, 4, 10-13. — Proposed honorarium to Assistant Secretary, 4. — Research, 5. — Donations to Library, 6, 14-19. — List of Papers, 6. — Attendances at meetings, 7. — Summer meeting and Autumn meeting, 7.

*Discussion.* — Adamson, D., Resolution respecting resignation of Secretary, 20. — Wise, W. L., Seconded resolution, 20. — Carbutt, E. H., Amendment referring Report back to Council with instructions respecting alterations in staff, 20. — Price-Williams, R., Seconded amendment, 21. — Boyd, W., Further amendment to omit instructions, 21. — Bennett, P. D., Seconded further amendment, 21. — Further amendment negatived, 21. — Previous amendment carried, 21. — Westmacott, P. G. B., Moved adoption of Report of Council subject to the amendment carried, 21. — Bell, I. L., Seconded motion, 21. — Motion carried, 21.

COURONNE, M., Boiler Feeder, Report on Fromentin Automatic Boiler Feeder, 1882, 487.

COURTNEY, F. S., elected Member, 1878, 558.

COURTNEY, W. M., elected Member, 1882, 254.

COVERING, NON-CONDUCTING, for boilers, 1874, 277.

COVERING, NON-CONDUCTING, for pipes, 1874, 270, 276, 277.

COWAN, H. J. F., elected Graduate, 1883, 310.

COWARD, E., elected Member, 1875, 65.

COWEN, E. S., elected Member, 1875, 314.

COWPER, C. E., elected Member, 1880, 310.

Locomotives, Fuel Consumption, 1884, 118.

Riveted Joints, 1881, 280.

Steam-ship "City of Rome," 1880, 357.

Tramways, Permanent Way, 1880, 220.

COWPER, E. A., elected Member of Council, 1874, 26. — 1877, 25. — Vice-President, 1878, 29. — President, 1880, 24. — 1881, 30.

Accidents, Mine, Mechanical Appliances for, 1877, 333, 337.

Addresses, Presidential, 1880, 28. — 1880, 312. — 1881, 413.

Axlebox, Radial, 1877, 311.

Barrow meeting, 1880, 36. — Reply to Mayor's welcome, 309. — *Address*, 312.

Bath, Floating Swimming, 1875, 148, 150.

Blast-Furnace Capacity, 1875, 373. — 1876, 34.

Blast Furnace Working, 1882, 310. — 1883, 151.

## COWPER, E. A. (continued).

- Board of Trade Regulations, 1878, 563.
- Boiler and Engine, High-Pressure, 1877, 147.
- Boiler, Lancashire, 1876, 88.
- Brakes, Automatic Action, 1880, 150.
- Brakes, Continuous, for railway trains, 1878, 98, 100.
- Brakes, Effect of, upon railway trains, 1878, 622.—1879, 211.
- Bridge, Erection of, over river Dal, 1876, 54.
- Cement, Portland, 1875, 56, 60.
- Chuck, Electro-Magnetic, 1875, 43.
- Coke Manufacture, 1883, 298.
- Cold Air, Machines for producing, 1881, 130, 132.
- Compressed-Air Machinery, 1874, 225.
- Compressed-Air Engines for Tramways, 1881, 669, 675.
- Constitution of Institution, 1878, 42.
- Cotton Spinning Machinery, 1880, 528.
- Council, Annual Report, 1882, 31.—1884, 20.
- Cultivation by Horses, 1880, 551.
- Diving Appliances, 1882, 194.
- Dock, Victoria Floating, 1878, 180.
- Docks, Cardiff, 1874, 135.
- Docks, Pumping Machinery, 1874, 157.
- Dredger, Bazin, 1882, 177.
- Drilling Machines for Boiler Work, 1878, 583.
- Dynamometer, Marine-Engine, 1877, 266.
- Dynamometers, 1876, 229, 238, 242.
- Electric Lighting, 1879, 254, 264.
- Engines, Pumping, Direct-Acting, 1874, 275.
- Expansion, Variable Automatic, 1877, 289.
- Feed-Water Heater and Filter, 1881, 545, 548.
- Filter, Farquhar, 1881, 159.
- Friction, 1883, 657.
- Gas Engine, Atmospheric, 1875, 201, 207, 210.
- Gauge, Railway, 1875, 77.
- Gauge, Standard, for High Pressures, 1880, 473.
- Governors, 1879, 415.
- Harvesting Machinery, 1881, 52.
- High-Pressure Vessels, 1878, 283.
- Hydraulic Machinery, Workshop, 1874, 186, 194.
- Injector Hydrants, 1879, 391.
- Iron and Steel for Boilers, 1879, 312, 314, 317.
- Iron and Steel, Physical condition of, 1884, 56.

## COWPER, E. A. (continued).

- Iron, Homogeneous, 1877, 85.
- Jute Machinery, 1880, 392, 393.
- Lead Processes, 1881, 536, 537.
- Leeds meeting, 1881, 623.
- Library, 1880, 186, 311.
- Locomotive, Brown's Tramway, 1880, 75.
- Locomotives, Compound, 1879, 354.
- Locomotives, Franco's Fireless, for Tramways, 1879, 635.
- Marine Engine, 1881, 481, *Note*.
- M.I.M.E., Use of initials, 1880, 311.
- Mines, Furness Iron Mines, 1880, 371.
- Mining Machinery, 1882, 367.
- Newcastle meeting, 1881, 32. — Reply to Mayor's welcome, 408.—  
Newcastle and Leeds meetings, 623.
- Paper Mill, Ogi, Japan, 1876, 157, 159.
- Patent Laws, 1875, 166.
- Plate Rolling Machinery, 1880, 98.
- Power Transmission, 1881, 99.
- President, on re-election as, 1881, 31.—*Addresses*, 1880, 28; 1880, 312;  
1881, 413. On nomination of, 1881, 411. On retiring from office of  
President, 1882, 33, 37.
- Presses, Hydraulic Packing, 1877, 364.
- Pressure-Intensifying Apparatus, 1878, 60.
- Printing Machinery, 1881, 523, 524.
- Puddling, Mechanical, 1876, 275, 284.
- Pump, Helical, 1874, 289, 294.
- Railway Traffic, Cost of, 1878, 206.
- Raising of wreck "Edith," 1878, 136.
- Research, 1882, 38.
- Riveted Joints, 1880, 186.—1881, 264, 267, 268, 270, 280, 282, 285.
- Rock-Drill, Diamond, 1875, 112.
- Rock-Drilling Machinery, 1877, 217.
- Rope Gearing, 1876, 389, 396.
- Rules, 1874, 31.—1876, 30.—1877, 39.—1878, 36.—1879, 585.—1880, 31, 35.
- Safety Lamps, 1879, 231, 236.
- Screw Propellers, 1879, 607.
- Secretary, Vote to late, 1878, 111.
- Shafting, Strength of, 1883, 211.
- Steam-ship "City of Rome," 1880, 358.
- Steel, Fluid-Compressed, and Guns, 1875, 288.
- Steel Boiler Experiments, 1878, 255, 257.



COWPER, E. A. (continued).

- Steel, Chernoff's papers, 1880, 232, 233, 235, 237, 239.
  - Steel Compression by Steam, 1880, 402, 413.
  - Steel, Hardening &c., 1882, 38.
  - Steel Plant, Bessemer, 1881, 636, 645.
  - Stone-Dressing Machinery, 1881, 140.
  - Thrashing Machines, 1881, 399, 405, 406.
  - Traction Engines in India, 1879, 522.
  - Tramways, Permanent Way, 1880, 220.
  - Tuyere, Open Spray, 1876, 365, 371.
  - Tynnewydd Colliery Inundation, 1877, 227.
  - Valve, Circular Slide-, 1877, 204, 230.
  - Valve-Gear, Joy's, 1880, 434, 446.
  - Valves, Safety, 1877, 186.
  - Ventilators for Mines, Mechanical, 1875, 327.
  - Water Meters, 1882, 82.
  - Water Pressure Regulators, 1879, 440.
  - Water Supply from Chalk, 1876, 170.
  - Watt, *Paper* on the Inventions of James Watt, and his Models preserved at Handsworth and South Kensington, 1883, 599.—Remarks, 622.
  - Wood-Working Machinery, 1875, 263.
  - Wool-Combing Machinery, 1882, 224, 229.
- COXHEAD, F. C., elected Member, 1878, 31.
- CRADLE FOR COALING, Westmacott's, 1884, 229.
- CRAMPTON, G., elected Member, 1883, 593.
- CRAMPTON, T. R., elected Member of Council, 1879, 33.—1882, 32.—Vice-President, 1883, 53.
- Boiler and Engine, High-Pressure, 1877, 137, 139.
  - Brake, Automatic Screw-Brake, 1882, 514.
  - Cold Air, Machines for producing, 1881, 128.
  - Compressed-Air Machinery, 1874, 228.
  - Cutting of Metals, 1883, 266.
  - Docks, Cardiff, 1874, 141.
  - Dredger, Bazin, 1882, 113, 114.
  - Expansion Gear, Automatic, 1882, 435, 436.
  - Filter, Farquhar, 1881, 157.
  - High-Pressure Vessels, 1878, 276.
  - Injector Hydrants, 1879, 387.
  - Iron and Steel for Boilers, 1879, 319, 322, 324.
  - Iron, Homogeneous, 1877, 83.
  - Locomotive, Brown's Tramway, 1880, 69.
  - Locomotives, Compound, 1879, 352, 353, 363; 1883, 450, 460.

## CRAMPTON, T. R. (continued).

Locomotives, Franco's Fireless, for Tramways, 1879, 627, 631.

Marine Engine, 1881, 497.

Patent Laws, 1876, 181, 185, 195.

Petroleum Fuel in Locomotives, 1884, 306.

Puddling, Mechanical, *Paper* on Mechanical Puddling, 1876, 244.—  
Remarks, 259, 287.

Rules, 1880, 34.—1878, 38.

Safety Lamps, 1879, 231.

Silver Ore Amalgamation, 1884, 267.

Steam-ship "City of Rome." 1880, 354.

Steel Plant, Bessemer, 1881, 640.

Stone-Dressing Machinery, 1881, 141.

Tramways, Permanent Way, 1880, 212.

Tunnel, Channel, *Lecture* on an Automatic Hydraulic system for  
Excavating the Channel Tunnel, 1882, 440.

Vote of thanks to retiring President, 1882, 36.—To President for Address,  
1883, 308.

Water-Pressure Mining Engines, 1880, 261, 262.

CRAMPTON, W., elected Member, 1876, 57.

CRANE, Movable Hydraulic, 1874, 131, 138.—1884, 229. Anti-breakage, 1874,  
128.—1884, 231. *See* Docks, Cardiff.

CRANK, patented in 1781 by Stead, 1879, 93.

CRANK SHAFTS, FORGING OF, 1879, 461. *See* Forging of Crank Shafts.

CRAVEN, J., elected Member, 1882, 254.

CREIL, Excursion to, at Paris Summer meeting, and Railway Brake Experiments,  
1878, 554.

CRIGHTON, J., elected Member, 1884, 1.

CROFT, H., elected Member, 1883, 309.

CROHN, F. W., elected Member, 1878, 107.

Locomotives, Compound, 1879, 357.

CROMPTON, R. E. B., elected Member, 1877, 71.

Boiler and Engine, High-Pressure, 1877, 149.

Electric Lighting, 1880, 277.

Locomotive, Brown's Tramway, 1880, 67.

Railway Electric Signals, 1884, 458.

Steel Compression by Steam, 1880, 414.

Traction Engines in India, *Paper* on the working of Traction Engines in  
India, 1879, 494.—Remarks, 513, 517, 530.

Tramways, Mechanical Traction, 1878, 430, 433.

Water Pressure Regulators, 1879, 439.

CROOK, C. A., elected Member, 1884, 79.

CROPPER, H. S., elected Member, 1883, 593.

CROSBY INDICATOR, 1884, 107.

CROSLAND, J. F. L., elected Member, 1881, 163.

CROSS, W., elected Member, 1882, 475.

CROSSLEY, F. W., Gas Engine, *Paper* on Otto and Langen's Atmospheric Gas Engine, 1875, 191.—Remarks, 211.

CROSSLEY, W. J., elected Member, 1875, 189.

CROW, G., Marine Engine, 1881, 484.

CROWE, E., decease, 1874, 2.—Memoir, 17.

CRUICKSHANK, W. D., elected Member, 1882, 475.

CRUNLIN VIADUCT, 1874, 250.

CRUSHING. *See* Disintegrator, Vapart, 1878, 490. *See* Silver Ore Amalgamation 1884, 257.

CULTIVATION BY HORSES, *Paper* on Implements and Machinery for Cultivating land by Horse-Power, by W. R. Bousfield, 1880, 529.—Requirements for cultivation of land, 529. — Implements employed, 530. — Drainage implements, 530.—Subsoil plough, 530.—Mole plough, 531.—Ploughs, general features, 532.—Share, 534.—Coulter, 535.—Breast, 536.—Section of furrow slice, rectangular or trapezoidal, 536.—Inclination of furrow slice, 536.—Proportions of furrow slice, 537.—Saving in time and labour by new proportions, 539.—Length and twist of breast, 539.—Fundamental form of breast, 540.—Variations for practical purposes, 542.—Breast for different depths, 544. — Breast best for work requires least draught, 545.—Plough-frame, sole-plate, and side-plate, 545.—Wheels for ploughs, 546.

*Discussion.*—Bousfield, W. R., Specimens of plough bodies from Howard, Ransomes Sims and Head, and Hornsby, 547.—Adamson, D., Growth of agricultural implement works, 549; means of improving agricultural implements, 549.—Cochrane, C., Principles of ploughing, 550.—Head, Jeremiah, Mole ploughing for drainage, 550; improvements in steam ploughing, 550; ploughing by lamp-light, 551.—Bousfield, W. R., Electric light for ploughing at night, 551.—Cowper, E. A., Ploughing with electric light, 551; advantage of single wire-rope, 552; cost and manufacture of hard-drawn steel wire-ropes, 552; deep ploughing by steam at Leicester, 552.

CUMMING, R., elected Graduate, 1883, 180.

CURETON, B. J., elected Member, 1884, 1.

CURRENT-METERS, Testing 1884, 190. *See* Testing Current-Meters.

CURRIE LONG-PULL MAGNET, 1884, 445. *See* Railway Electric Signals.

CURRY, W., elected Member, 1874, 256.

CURTIS, R., elected Member, 1875, 314.

CUSS, H. B., elected Member, 1876, 57.

CUTTING OF METALS, *Paper* on some modern systems of Cutting Metals, by W. Ford Smith, 1883, 226.—Tool-holders and cutters, 226.—Swivel tool-holder, 227.—Parting-off tool-holder for capstan-rest chasing-lathe, 230.—Angles of cutting and of clearance, 230.—Requirements for cutters, 231.—Machines for grinding cutters, 232.—Sheet-steel angle-gauges, 233.—Re-hardening of cutters, 233.—Speed and depth of cut with swivel tool-holder, 234.—Broad-cutting, 235.—Twist-drills, 236.—Angle for the cutting lips, 237.—Previous constructions of twist-drills, 238.—Perfection of holes produced by twist-drills, 239.—Angle of clearance, 239.—The grinding line, 240.—Machine for grinding twist-drills, 241.—Results of working with twist-drills, 242.—Milling, 243.—Making and maintaining of milling cutters, 245.—Mode of setting, 246.—Face-milling cutters, 246.—Cylindrical cutter with spiral teeth, 246.—Other forms of milling cutters, 247.—Size and material of milling cutters, 248.—Cutting speed in milling, 248.—Tabular comparison of time occupied in roughing-out and finishing with different tools, 250-1.

*Discussion.*—Smith, W. Ford, Examples of work done by milling and by shaping machines, 252.—Wicksteed, J. H., Point of ordinary drill does not cut, 253; advantage of small hole to start with, 253; proportion of feed to number of revolutions, 253; comparison of swivel tool-holder and ordinary slide-rest, 254.—Paget, A., Mode of grinding ordinary drill, 255; difficulty arising from blunt point in twist-drills, 255.—Auderson, W., Comparative finish produced by milling and by shaping, 255.—Longworth, D., Adoption of one cutting angle for both cast and wrought iron, 256; value of accuracy in cutting-edge, 256; dispensing with rose-bit in drilling, 256; emery-wheel for sharpening the milling cutters, 256; milling of brass, 257.—Head, J., What kind of steel employed for cutters, 257; extension of milling in engineering work, 258.—Fielding, J., Use of chilled cast-iron cutters for high speeds, 258.—Robinson, J., Previous use of revolving cutters, 259; forms and construction of cutters, 259; increased number of joints, 260; mode of grinding the cutters, 260; disadvantage of cast-iron tools, 260.—Fielding, J., Re-melting of old cast-iron tools, 261.—Hulse, W. W., Limited use of toolholders, 261; large cuttings now taken from lathes, 261; relative advantages of flat drills, of bar-tools, and of circular cutters, 262.—Kitson, J. H., Specimens of work done by large revolving cutters, 262; advantage of grooved milling cutter for roughing, 263.—Westmacott, P. G. B., Endurance of milling tools, 263; advantage of grooving in cylindrical milling cutters, 264; milling of brass, 264; large heavy tools required for heavy work, 264; tools of Mushet steel, 264; relative advantages of flat drills and twist-drills, 265.—Paget, A., Hollow turning tool cooled by water, 265.—Westmacott, P. G. B., Water not wanted with large steel tools, 266;

## CUTTING OF METALS (continued).

cast-iron tools for hardest castings, 266.—Crampton, T. R., Advantage of firmness in cutting tools, 266.—Smith, W. F., Modes of obviating thick point of drill, 266; rate of feed, 267; overhang of tools or holders, 267; stability and cutting power of round tool-holders, 268; roughing out heavy forgings, 268; relative finish by milling and by shaping or slotting, 269; objection to adoption of two cutting angles, 269; use of tool-holders for broad-cutting, 269; adjustable rymmer instead of rose-bit, 270; milling cutters for gun-metal and brass, 270; different qualities of cast steel for cutters, 270; chilled cast-iron tools, 271; maximum speed of cutting, 271; re-grinding of milling cutters, 271; special forms of cutting tools, 272; general advantage of tool-holder system, 272; hollow tool cooled by water, 272; extensive applicability of tool-holder system, 272; grooved milling cutter requires reduction of speed, 272; increased feed in drilling with twist-drills, 273; difficulty of maintaining proper angles in flat drills, 273; small cost of twist-drills, 273; saving in wages by tool-holder system, 274.

CYFARTHFA IRON WORKS, visited at Summer meeting, Cardiff, 1874, 239.—1884, 358, 377-380.

CYMMER COLLIERY, visited at Summer meeting, Cardiff, 1884, 357, 371.

## D.

DADY, J. N., elected Graduate, 1879, 38.

DAGLISH, G. H., Engines, Winding, Direct-Acting, *Paper* on Direct-Acting Winding Engines for Mines, 1875, 217.—Remarks, 243, 244.

D'ALBERT, C., elected Member, 1883, 309.

DAL BRIDGE, 1876, 46. *See* Bridge, Erection of.

DALLEMAGNE, J., Description of the Sclessin Iron Works, 1883, 535.

D'ALTON, P. W., elected Member, 1881, 409.

DAM, La Gileppe Reservoir, 1883, 516, 553.

DANIEL, W., Compressed-Air Machinery, *Paper* on Compressed-Air Machinery for Underground Haulage, 1874, 204.—Remarks, 216, 220, 229.

Locomotives, Compound, 1879, 351, 363.

Ventilators for Mines, *Paper* on Mechanical Ventilators for Mines, 1875, 317.—Remarks, 326, 330.

DAPPLES, E., Tunnel, St. Gothard, *Letter* on, 1883, 177.

DARBY, A., decease, 1879, 22.—Memoir, 9.

DARBY, C. E., memoir, 1884, 400.

DARLING, W. L., elected Member, 1879, 583.

DARLINGTON'S ROCK DRILL, 1874, 79.



DARWIN, H., elected Member, 1878, 293.

Brakes, Effect of, upon railway trains, 1878, 486.

Dynamometers, 1876, 231.

DAVEY, H., Accidents, Mine, Mechanical Appliances for, 1877, 327, 337, 338.

Brake, Automatic Screw-Brake, 1882, 511.

Centrifugal Separator, 1882, 525.

Engines, Pumping, *Paper* on Direct-Acting Pumping Engines and Pumps for high lifts in mines, 1874, 258.—Remarks, 271, 272, 273, 277.

Engines, Winding, Direct-Acting, 1875, 235.

Friction Experiments, 1883, 654.

Hydraulic Machinery, Marine, 1874, 47.

Mining Machinery, *Paper* on Mining Machinery, 1882, 319.—Remarks, 364, 380.

Presses, Hydraulic Packing, 1877, 366, 367.

Railway Electric Signals, 1884, 466.

Steel, Fluid-Compressed, and Guns, 1875, 292.

Water-Pressure Mining Engines, *Paper* on Water-Pressure Engines for mining purposes, 1880, 245.—Remarks, 257, 261, 262, 263.

Watt, Inventions of James Watt, 1883, 628.

DAVIDSON, G., elected Member, 1883, 33.

DAVIDSON, J., elected Member, 1881, 163.

DAVIDSON, J. Y., elected Member, 1884, 79.

DAVIES, A. H., elected Member, 1884, 198.

DAVIES, C. M., elected Member, 1880, 185.

DAVIES, J., elected Member, 1881, 409.

DAVIS, A., elected Member, 1874, 55.

Lifts, Hydraulic, 1882, 159.

Secretary, appointment, 1884, 77, 78.

Steel Compression by Steam, *Paper* on the Steel Compressing arrangements at the Barrow Works, 1880, 396.—Remarks, 415.

DAVIS, J., elected Graduate, 1876, 28.

DAVISON, J. W., elected Member, 1877, 71.

DAVISON, R., elected Member, 1884, 1.

DAVY SAFETY LAMP, 1879, 219. *See* Safety Lamps.

DAVY, W. S., elected Member, 1874, 256.

DAW, J. G., elected Member, 1883, 309.

Injector, Automatic, 1884, 181.

DAW, S., elected Member, 1874, 101.

DAWSON, B., elected Member, 1879, 155.

DAWSON, E., elected Graduate, 1875, 315.

DAWSON, T. J., elected Member, 1876, 347.

DAWSON, W., elected Member, 1877, 71.

- DEACON, F. H., elected Graduate, 1875, 315.
- DEACON, G. F., elected Member, 1874, 256.  
     Gas-Engine, Atmospheric, 1875, 208.  
     Steel, Fluid-Compressed, and Guns, 1875, 296.  
     Ventilators for Mines, Mechanical, 1875, 328.
- DEACON METER, Testing, 1884, 191, 193. *See* Testing Current-Meters.
- DEACON, R. W., elected Member, 1880, 489.
- DECAUVILLE, P., elected Member, 1884, 79.  
     Portable Railways, *Paper* on Portable Railways, 1884, 126.
- DEAKIN, T., elected Member, 1874, 101.
- DEAN, F. W., elected Member, 1883, 593.
- DEAN-PITT, Lieut. S., Diving experiences in connection with H.M.S. "Dotrel,"  
     1882, 198, 201.
- DE BERGUE, C., decease, 1874, 2.—Mémorial, 18.
- DEES, J., decease, 1876, 3.—Mémorial, 19.
- DEES, J. G., elected Member, 1877, 71.
- DE HEMPTINNE'S COTTON SPINNING WORKS, visited at the Belgian Summer  
     meeting, 1883, 517.—Description, 565.
- DE LAVELEYE, E., Honorary Local Secretary for Liège, 1883, 313.  
     Liège Iron and Coal Industries, *Paper* on the History of the Iron and Coal  
     Industries in the Liège district, 1883, 329.
- DELEBECQUE, Lartigue, and Banderai's railway brake apparatus, 1878, 554.
- DENISON, S., elected Member, 1882, 254.
- DENNIS, W. F., elected Member, 1883, 309.
- DENNY, W., elected Member, 1882, 15.  
     Ships, Iron and Steel for, 1881, 558, 579.
- DE PAPE, W. A. H., elected Member, 1880, 185.
- DEPREZ, J., Val St. Lambert Glass Works, 1883, 544.
- DERHAM, J. J., decease, 1884, 3.
- DE SINÇAY, ST. P., Address of welcome to members visiting Vieille Montagne  
     Zinc Works, 1883, 514.  
     Zinc, *Paper* on the Manufacture of Zinc in Belgium, 1883, 345.
- DE WAEL, L., Mayor of Antwerp, Welcome to members at Belgian meeting,  
     1883, 313.
- DIAMOND ROCK-DRILL. *See* Rock-Drill, Diamond, 1875, 92. *See also* 1874, 249.
- DIAMOND WORKS, Antwerp, visited at Belgian meeting, 1883, 517, 561.
- DICK, F. W., elected Member, 1883, 309.
- DICK, G. G., elected Member, 1882, 254.
- DICKINSON'S BOILER DRILLING AND TURNING MACHINE, 1878, 571, 575, 576, 577.
- DICKINSON, J., elected Member, 1880, 9.
- DICKINSON, W., elected Member, 1875, 65.
- DICKSON, J., elected Member, 1879, 397.

DIFFERENTIAL PUMPING ENGINES, 1874, 270.—Compound, 260, 262, 271. *See* Engines, Pumping, Direct-Acting.

DIPLOMAS of Membership in Institution, 1878, 43, 114, 562.

DIRECT-ACTING CIRCULAR SAW, 1875, 126. *See* Saw, Circular, Direct-Acting.

DIRECT-ACTING PUMPING ENGINES, 1874, 258. *See* Engines, Pumping, Direct-Acting.

DIRECT-ACTING WINDING ENGINES, 1875, 217. *See* Engines, Winding, Direct-Acting.

DISINTEGRATOR, VAPART, *Paper* on the Vapart Disintegrator, by P. Closson, 1878, 490.—Different modes of disintegrating materials, 490.—Description of Vapart disintegrator, 491.—Practical details of construction, 491.—Special form for agricultural purposes, 493.—Methodical distribution of material, 494.—Results of Vapart disintegrator in various cases, 496.—Principles of Vapart disintegrator, 497.—Table of calculated values for two sizes of disintegrator, 501.

*Discussion.*—Cochrane, C., What is economy of working as compared with edge runners, 502.—Closson, P., Advantages of disintegrator over edge runners, 502.—Ellington, E. B., Vapart disintegrator as used in London, 502.—Robinson, J., Machinery will be everywhere substituted for hand labour, 503.

DISSOCIATION of oxygen and carbon at high temperatures in steel-melting, 1875, 300.

DIVING APPLIANCES, *Paper* on Appliances for Working under Water or in Irrespirable Gases, by W. A. Gorman, 1882, 179.—History of diving, 179.—Smeaton's diving bell, 181.—Kleingert's dress, 181.—Rennie's diving bell, 182.—Siebe's open diving dress, 182.—Siebe's close diving dress, 183.—Modern apparatus, 183.—Air-compressing pump, 183.—Table of corresponding depths and pressures, 184.—Air-distributing arrangement, 185.—Helmet, 185.—Waterproof dress, 186.—Experience in working, 186.—Fleuss apparatus for working in irrespirable gases, 187.—Electric light and telephone for divers, 189.

*Discussion.*—Gorman, W. A., Recent use of Fleuss apparatus, 189.—Fleuss, H. A., Description of breathing apparatus, 190; construction of carbonic-acid filter, 191.—Head, J., Enquires composition of air in bag, 191.—Fleuss, H. A., Atmospheric air with less oxygen, 191.—Cochrane, C., Prompt repair by diver at colliery, 191.—Halpin, D., Milling of knobs fixing glass shield in helmet, 192.—Hawksley, C., Repair of pump in well by diver, 192; diving operations in Lowestoft harbour, 192; diving bell at Barbadoes, 193.—Gorman, W. A., Model of Barbadoes diving bell, 193; electric lamp for use under water, 194.—Cowper, E. A., Use of electric light for fishing, 194.—Halpin, D., Ejection of paraffin keeps fish away from lamp, 194.—Marten, E. B., Use of diving apparatus for liberating lifts in colliery shafts, 195.—Hawksley, C., Division of water-ballast

## DIVING APPLIANCES (continued).

chamber in diving bell to prevent canting, 195.—Fleuss, H. A., Description of oxy-hydrogen lamp for use in dangerous gases, 195; saving of life by use of apparatus, 197.—Cochrane, C., How can breathing apparatus be promptly charged with oxygen, 197.—Fleuss, H. A., Describes mode of charging, &c., 197.—Head, J., Cost of breathing apparatus and lamp, 198.—Fleuss, H. A., Particulars of cost, 198; training of men, 198.—Westmacott, P. G. B., Introduces Lieut. Dean-Pitt, 198.—Dean-Pitt, S., Diving operations at *Doterel* wreck, 198; strength and efficiency of apparatus, 200; submarine electric light and telephone, 200.—Anderson, W., Temperature inside diving dress, and degree of light in deep water, 201.—Dean-Pitt, S., Temperature very high when at work, 201; diver can see to 7 or 8 feet, 201.—Gorman, W. A., Milling of knobs for eye-glass, 201; short segment-screw not desirable, 201; divers prefer working without artificial light, 202; air-lock diving bell with water-ballast chamber, 202; training of divers, and value of results, 202; submarine telephone, 203.

DIXON AND BURNE'S LIMESTONE PIT, 1876, 338.

DIXON, J., elected Graduate, 1884, 2.

DIXON, S., elected Member, 1883, 593.

DOBSON, B., decease, 1875, 3.—Mémorial, 20.

DOCK AND HARBOUR WORKS, visited at Glasgow meeting; Greenock, 1879, 579.

DOCK, VICTORIA FLOATING, *Paper* on a Floating Dock upon an improved system, at the Victoria graving docks, by C. Elwin, 1878, 139.—Description of ship-lifting appliances at Victoria graving docks, 139.—Old process of docking, 140.—Object of new floating dock, 141.—Description of floating dock, 141.—Dimensions, 142.—Process of lifting ships on the dock, 143.—Principal requirements as met by dock, 144.—Construction of cross girders, 145.—Main girders, 147.—Closed end of dock, 148.—Gate end, 149.—Gates, 150.—Crane, 151.—Pumping engines, 152.—Bilge-blocks, 152.—Arrangement for building and launching of dock, 153.—Weight of dock, 154.—Appendix of calculations, 155.—Calculation of stresses on flanges of main girders when dock is afloat, 155.—Ditto when dock is on lift, 163.—Stresses on flanges of cross girders, 163.—Stresses on cross girder at gate end of dock, 172.

*Discussion.*—Bramwell, F. J., What is maximum weight of ship, and what proportion of that weight is carried by hydraulic lift, 175; capacity of lift materially increased by new system, 175.—Elwin, C., Power of lift, 176.—Bramwell, F. J., Would lift dock be preferable to floating dock in case of entirely new work, 176.—Halpin, D., Conditions imposed in designing the floating dock, 177; crane for lifting propellers, 178; schemes considered for building the floating dock, 178.—Bramwell, F. J.,

## DOCK, VICTORIA FLOATING (continued).

Construction of St. Thomas floating dock, 179; Miers' plan of movable cofferdam for removing screw-propeller, 179.—Boyd, W., Floating dock for Bermuda, constructed on the Tyne, 180.—Markham, C., Difficulty of fixing bilge-blocks to secure a ship on the dock, 180.—Cowper, E. A., High-sided floating dock would do work of hydraulic presses, 181.—Halpin, D., High-sided dock would have involved much greater expense, 181.—Bramwell, F. J., Would combined system be recommended elsewhere, instead of independent floating dock, 182.—Halpin, D., Would certainly not adopt combined system except under special conditions described in paper, 182.—Elwin, C., No difficulty in fixing ship securely on floating dock by bilge-blocks, 182.—Robinson, J., Value of such contrivances in keeping off war, 182.

DOCKS, ANTWERP, 1883, 494, 516, 557.—Ghent, 517, 566.

DOCKS, AVONMOUTH, 1877, 297.

DOCKS, BARROW-IN-FURNESS, Paper on the Docks and Railway Approaches at Barrow-in-Furness, by F. C. Stileman, 1880, 324.—Development of Furness Railways, and of iron ore traffic, 324.—Growth of Barrow harbour and docks, 325.—Devonshire and Buccleuch docks, 325.—Ramsden and Cavendish docks, 326.—Masonry and concrete, 326.—Steam navy, 327.—Basin and dock gates, 327.—Railway and road approaches, 328.—Buccleuch dock bridge, 328.—Hydraulic machinery, 328.—Barrow harbour, 329.

*Discussion.*—Ormiston, T., Graving dock, why outside the dock entrance, 329; inner lock cill, why raised, 330; dock entrance, why so wide, 330; silting in outside channel, 330.—Strype, W. G., Construction of quay walls by pouring concrete *in situ* very advantageous, 330.—Rennie, G. B., Why three different sections of dock wall, 331; cost of excavating by steam navy as compared with hand labour, 331.—Ramsden, Sir J., Graving dock placed outside for economy, 331; advantages of wide entrance to docks, 332; absence of silting, 333; scour of tide, 333; water level in docks, and height of inner lock cill, 333.—Stileman, F., Different sections of dock wall, 333; cost of excavating by steam navy, 334; pouring concrete down tubes, and depositing it by buckets, 334; dredging, 334; spring girders of Buccleuch dock bridge, 335.

DOCKS, CARDIFF, Paper on the Bute Docks, Cardiff, and the Mechanical Appliances for shipping Coal, by J. McConnochie, 1874, 119.—Description of the docks, 119.—New basin, 121.—Lock gates, 122.—Trade carried on, 123.—Coal tips for shipping coal, 124.—Balance tips, 125.—Armstrong's hydraulic tips, 126.—Anti-breakage crane for reducing loss of coal by breakage, 128.—Comparison of balance and hydraulic tips, 129.—Hydraulic hauling engine, 130.—Portable hydraulic crane for discharging cargoes, 131.—Motive power for working hydraulic machinery, 132.



## DOCKS, CARDIFF (continued).

*Discussion.*—Westmacott, P. G. B., First application of coal-shipping machinery, 133; endless-chain system for hauling wagons, 133.—Newton, W. E., Price's plan for trimming coal in ship's hold by a distributing cone, 134.—Williams, R. P., Plimsoll's plan for preventing breakage of coal by series of inclined planes, 134.—Cowper, E. A., Arrangement for keeping a vessel upright after ballast is taken out, 135; advantage of hydraulic machinery, 136; arrangement for examination of machinery by turning over, 136; shipping coal by a movable telescopic tube to prevent breakage, 136; arrangement for trimming coal &c., 136.—Head, J., Coal more efficient in a pulverised than in a solid state, 137; ballast from ships depositing on foreshore, 138; steam cranes preferable to portable hydraulic crane, 138.—Tweddell, R. H., Hemp packing for hydraulic machinery better than leather, both as inside and outside packing, 138.—Walker, B., Leather packing better than hemp, and causes less friction, with clean water, 139; leather packing soon worn out with dirty water, 140.—Homersham, S. C., With clean water metallic packing superior to either leather or hemp, 140.—Walker, B., Metallic packing requires extreme cleanliness, 140.—Crampton, T. R., Economy of using coal in a pulverised state, 141; results of trials, 141.—McConnochie, J., Breakage of coal caused by crushing in shoots and in trimming, not by falling into ship's hold, 143; breakage much reduced by trimming with barrows, 143; booms for keeping the vessels steady and upright when ballast is out, 143; hydraulic hauling engine modification of capstan engine, 144; cost of shipping coal by hydraulic tips, 144.

DOCKS, CARDIFF, *Paper on recent extensions of Dock Accommodation and Coal-Shipping Machinery at the Bute Docks, Cardiff, by J. McConnochie, 1884, 227.*—Roath Dock, 227.—Coal-shipping machinery, 228; movable hydraulic crane, 229; Westmacott's coaling cradle, 229; anti-breakage crane, 231; tips for shipping coal, 231.—Trade at Bute docks, 232.—Railways, 232.—Sidings, 232.—Graving docks, 233:—Public graving dock, 233; caisson, 233; centrifugal pumps, 234; lift pumps, 235.—Hills' graving docks, 235-6.—Cardiff Junction graving dock, 236; caissons, 237; centrifugal pumps, 237; bucket pumps, 237.—Mountstuart graving docks, 238.—Bute graving dock, 238.—Gridiron, 239.

*Discussion.*—Walker, B., Invention of movable hydraulic crane, 239; first cost of crane less when portable than when fixed, 239; ingenious anti-breakage arrangement, 240; further room for improvement in coal-shipping machinery, 240.—Tomlinson, J., Increase of coal-shipping, 240; invention and introduction of movable hydraulic crane, 241.—McConnochie, J., Origination of movable hydraulic crane, 241.

DOCKS, DRY, Chatham, 1874, 145.—Rio de Janeiro, 1874, 156.

DOCKS, GRAVING, 1884, 233-239; 360, 362, 363, 393, 394.

DOCKS, PENARTH, 1874, 162,—1884, 357, 367-9.

DOCKS, PUMPING MACHINERY, *Paper* on the Pumping Machinery for emptying the Dry Docks at Chatham, and at Rio de Janeiro, by G. B. Rennie, 1874, 145.—Difficult navigation of Medway at Chatham, 146.—Description of new dry docks, 146.—Pumping machinery for emptying docks, 147.—Arrangement of centrifugal pumps, 148.—Results of experimental pumps, 150.—Water discharged in emptying docks, 151.—Trials of working of pumps, 152.—Engines for driving centrifugal pumps, 154.—Sluices, 155.—Dry docks at Rio de Janeiro, 156.

*Discussion*—Rennie, G. B., Measure of the friction of water in culverts, 157.—Cowper, E. A., Proper curve for the arms of centrifugal pump, 157.—Rennie, G. B., Collar bearings on pump shaft, 158; sluices with wood face bearing against granite face, 158; grooves for sluices easily cleaned out, 158; consumption of fuel by pumping engine, measurement by water from surface condenser, 159.—Bramwell, F. J., Percentage of useful effect with centrifugal pumps, 161; best arrangement when working is not continuous, 161.

DOCKS, SUNDERLAND, visited at Summer meeting, Newcastle, 1881, 615-618.

DOCKS, visited at Summer meeting, Cardiff, 1884, 356. Penarth, 357, 367-9. Alexandra, Newport, 359, 392-4.

DODD, J., elected Member, 1880, 310.

DODSON, E., elected Associate, 1882, 16.—Decease, 1884, 3.—Memoir, 62.

DONALD, J., elected Member, 1880, 489.

DONALDSON, J., elected Member, 1876, 27.

DONATION to Library of Institution of Civil Engineers, 1878, 215.

DONATIONS TO LIBRARY. *See* Library.

DONNELLY, J., elected Member, 1884, 198.

DOSSOR, A. L., elected Member, 1877, 71.—Decease, 1882, 17.—Memoir, 5.

DOTEREL, Diving operations at wreck of H.M.S. "Doterel," 1882, 198.

DOUGLASS, J. N., elected Member, 1879, 37.

DOUGLASS, W., elected Member, 1879, 38.

DOULTON, B., elected Member, 1879, 583.

DOWLAIS IRON WORKS, Blast furnace, large regenerative hot-blast stoves, Siemens-Martin steel works, and steel rail mill, 1874, 239.—Visited at Summer meeting, Cardiff, 1884, 358, 374-377.

DOWNING, S., decease, 1883, 36.—Memoir, 16.

DOWSON, J. E., elected Member, 1881, 409.

DOXFORD, R. P., elected Member, 1880, 489.

DREDGE, J., elected Member, 1874, 101.

DREDGER, *Paper* on the construction and working of a Vertical-action Steam Dredger in India, by R. B. Buckley, 1879, 534.—Description of Fouracres dredger, 534.—Mode of working, 537.—Results of working, 539.—

## DREDGER (continued).

Advantages for working in rough water, 542.—Ditto in tidal waters, 543.—Particulars of work done, 543.—Comparative performances of various dredgers in Bengal, 544.—Small cost of repairs with Fouracres dredger, 545.—Cost of dredging in England, 546.—Design for large dredger, 547.—Appendix, Particulars of working with Fouracres dredger, 550–551.—Table of dredging done by different machines in Bengal, 552–553.

*Discussion.*—Buckley, R. B., Wear of parts of bucket, 554; cost of dredging on Thames, 554.—Appleby, C. J., Advantage of hemispherical form of scoop over semi-cylindrical, 554; Bruce's excavator with hemispherical scoop, as used in Plymouth harbour, 555; use of Bull's and Bruce's excavators in India, 557.—Thomson, J., Dredging plant much needed in Demarara, 557.—Brown, A., Field for Fouracres dredger, 557; cost and amount of work done by improved ladder dredgers, 558.—Easton, J. M., Use of Bull's excavators in sinking wells, 559.—Buckley, R. B., Hemispherical bucket acts entirely by weight, 559; advantage of large size for such buckets, 559; special feature of Fouracres dredger is the spear, 560; suitability for dredging in Demarara, 560; "spider" used at Ravi bridge, 561; large dredgers could be made on this system, 561; advantages and principle of Fouracres dredger, 562.—Robinson, J., Tables useful in comparing work done, 562.

DREDGER, BAZIN, *Paper on the Bazin system of Dredging*, by A. A. Langley, 1882, 100.—Construction of Bazin dredger, 100.—Applications, 101.—Experience in working, 102.—Chief difficulties, and mode of remedying, 103.—Cost of working, 104.

*Discussion.*—Langley, A. A., Advantage of driving pump through belt, 105; use of dredger to pump water, 105; comparison of Bazin dredger with bucket dredger, 106.—Skerrett, C. P., Previous use of bucket dredgers at Lowestoft, 106; particulars of working of Bazin dredger, 106; hopper barges, 107; construction of fan, 107; cost of dredger barge, 108; dredging of pockets in Lowestoft harbour, 108; use of dredger as centrifugal pump, 108.—Ball, C., Difference between original Bazin dredger and present Ball dredger, 109; practical improvements in Ball dredger, 109; arrangement for placing pump above water level, 110; delivery of spoil through long pipes, 111; forked suction pipe, 112; price of dredgers, 112; advantage of Ball dredger for shallow water, 113.—Crampton, T. R., Enquires length of pipe through which the spoil can be delivered, 113.—Ball, C., Longest distance 600 yards, 113; spiral rib in delivery pipe for prevention of settling, 114.—Crampton, T. R., Minimum velocity of delivery to prevent settling, 114.—Ball, C., Relation between length of delivery pipe and power required, 114.—Langley, A. A., Proportion of water to sand, and to clay, 115.—

## DREDGER, BAZIN (continued).

Westmacott, P. G. B., Form of fan blades, and amount of clearance, 115.—Langley, A. A., Clearance and eccentricity of blades, 115.—Hawksley, C., Facility of dredging out pockets, 116; settlement of dredged mud in barges, 116.—Langley, A. A., Longitudinal boards to facilitate settlement, 116.—Hawksley, C., Transverse arrangement preferable, 116.—Langley, A. A., Complication in using many barges, 116.—Cowper, E. A., Dr. Potts' plan of excavating by vacuum, 117.—Anderson, W., Note on dredging by centrifugal pumps at Chatham Dockyard and Amsterdam Canal, 117.

DRILL, DIAMOND. *See* Rock-Drill, Diamond, 1875, 92. *See* also 1874, 249.

DRILLED RIVET HOLES, advantages of, 1876, 71, 96, 97, 110.

DRILLING. *See* Steel Boiler Experiments, 1878, 222, 229. *See* Drilling Machines.

DRILLING MACHINES FOR BOILER WORK, *Paper* on Drilling Machines used for boiler work, by W. S. Hall, 1878, 565.—Two classes of drilling machines, for drilling in the shop, or in place, 565.—Multiple drilling machines, 565.—Hutchinson's multiple drill, 565.—Group of drill spindles carried on sliding saddle, 566.—Buckton and Wicksteed's multiple drill, 566.—Adjustment of distance between drills by screws of varying pitch, 567.—Welch's adjustment of distance by hollow screw, 567.—Buckton's machine for drilling in circular arc, 567.—Jordan's machine for drilling and turning flanged ends, 568.—Drilling of tube-plates, 569.—McKay's hydraulic equilibrium tool, 569.—Modification for boring conical holes, 569.—Tool for cutting out large holes for flues, &c., 569.—Adamson's machine for drilling boiler shells, 570.—Allan's ditto, 570.—Kennedy's ditto, 571.—Dickinson's boiler drilling and turning machine, 571.—Jordan's ditto, 571.—Hall's portable inside-drilling machine, 572.—Brown's portable steam drill, 573.—Thorne's portable drilling machine, 573.—"Stow" flexible shaft, 574.—Relative duty performed by four shell-drilling machines, 575.—Relative advantages of the four machines, 576.

*Discussion.*—Hall, W. S., Improvements in Dickinson's and Jordan's machines, 577; Scriven's radial multiple drill, 577.—Wicksteed, J. H., Proportion of work done to number of drills, 578; advantages of screw as against lever feed-motion, 578.—Welch, E. J. C., Improved adjusting gear for distance of drills, 579; twist-drills rarely break, 579; boiler plates should be drilled flat, and holes rimmed out, 580; inside-drilling machine, 580.—Hetherington, T. R., Machines for drilling cylinders of carding engines, 581.—Richardson, W., Early form of multiple drill for carding engines, 581; objections to drilling of boiler plates before bending, 582.—Head, Jeremiah, Objections to drilling before bending in case of ship plates, 582.—Cowper, E. A., Enquires first cost of Hall's machine, 583.—Williams, R. Price, Drilling is now superior to punching even in economy, 583.—Paget, A., Distress from bending is less in ship plates than in boiler plates, 583.—

# DRILLING MACHINES FOR BOILER WORK (continued).

Adamson, D., Internal drilling is not the best system, 584; apparent advantage of twelve drills in multiple drill, 584; has gradually abandoned punching completely for boilers, 584; multiple drill for boiler work is a misapplication, 585; better to work with a single drill, using several machines, 585; drilling boilers from inside is open to question, 586; injury done by bending after punching, 586; dictation of Boiler Associations is as objectionable as that of Board of Trade, 587; injury done by punching is not always repaired by annealing, 587.—Platt, J., Difficulty of supporting plate firmly in drilling after bending, 588.—Hall, W. S., With his own machine, man remains always inside the boiler, 588; cannot give selling price, 588.—Robinson, J., Whole question is treated with utmost impartiality in the paper, 588; importance of drilling after bending, not before, 589.

DRILLING MACHINES FOR ROCK, DIAMOND. *See* Rock Drill, Diamond, 1875, 92, *See also* 1874, 249.

DRILLING MACHINES FOR ROCK, PERCUSSIVE. *See* Rock Drilling Machinery, 1874, 77.—1877, 206. *See also* 1875, 103, 109, 111, 113.

DRUITT, T., elected Treasurer, 1878, 560.

DRUMS FOR WINDING ENGINES, 1875, 223, 237, 241.

DRURY, R. F., elected Associate, 1882, 146.

DÜBS, C. R., elected Member, 1877, 71.

DÜBS, H., decease, 1877, 2.—Mémorial, 18.

DÜBS, H. J. S., elected Member, 1877, 71.

DUCKHAM, F. E., elected Member, 1880, 310.

DUCKHAM, H., elected Member, 1881, 9.

DUDLEY PORT LIMESTONE PIT, 1876, 338.

DUESBERG-DELREZ, Wool-Card Manufactory, visited at Belgian meeting, 1883, 516.—Note on Works, 552.

DUGARD, W. H., Steel, Hardening &c., 1882, 146.

DUNCAN, D. J. R., elected Member, 1879, 397.

DUNLOP, D. J., Governor, *Paper* on the Pneumatic Marine Governor, 1879, 406.—Remarks, 415, 419.

DUNLOP, J. M., decease, 1879, 22.—Mémorial, 9.

DUNN, H. W., elected Member, 1881, 624.

DUNN, T. E., decease, 1879, 22.—Mémorial, 10.

DURHAM, F. W., Governor, *Paper* on the "Velometer" Governor, 1879, 410.—Remarks, 415, 421.

DURIE, J., elected Member, 1875, 314.

Rope Gearing, *Paper* on Rope Gearing for the Transmission of large Power in mills and factories, 1876, 372.—Remarks, 382, 398.

DUST-FUEL, Furnace for. *See* Puddling, Mechanical, 1876, 244. *See also* 1874, 137, 141; and 1877, 84.



DYEING AND LAUNDRY WORKS, Cardiff, 1884, 366.

DYNAMITE, use in mining operations, 1874, 85, 91, 93; in submarine blasting, 1875, 104, 106, 108.

DYNAMO-ELECTRIC MACHINES. *See* Electric Lighting.

DYNAMOMETER, MARINE-ENGINE, *Paper* on a new Dynamometer for measuring the power delivered to the Screws of large ships, by W. Froude, F.R.S., 1877, 237.—Friction brake involved such great difficulties as induced the writer to seek some fresh *modus operandi*, 237.—Principle of the new turbine dynamometer, 238.—Nature of current-growth established in the instrument, 240.—Manner in which the currents produce the dynamometric reaction, 241.—Adequate amount of reaction can be produced by an instrument of convenient size, 243.—Same instrument can be adjusted to deal with different powers, 244.—Details of application to any given ship, 245.—Arrangement of dynamometric apparatus, 247.—Manner of dealing with heat developed in the instrument, 250.—Advantages of thus measuring the power actually transmitted by marine engines, 251.

Appendix explanatory of the dynamical principles of the turbine dynamometer, 252.—Conception of water spaces as occupied by a series of pipes through which streams flow, 252.—Conditions established at the region of transference, 254.—Determination of the external and internal forces exerted by any stream, 256.—Means of obtaining an equation for the total force-moment of the machine, 259.

*Discussion.*—Froude, W., Illustrations of power of current-growth in dynamometer cells, 261; if there were no frictional resistances to water, the power-absorbing capabilities of dynamometer might become infinite. 262.—Hawksley, T., Application might be extended to number of dynamometrical uses, 263.—Brotherhood, P., Apparatus would form admirable marine-engine governor, 263.—Rich, W. E., Heating of water within instrument in absorbing power, 264; means of making the instrument self-governing, 264; form of dynamometer spring, 264.—Hawksley, C., Means of cooling water in dynamometer, 265.—Cowper, E. A., Most ingenious apparatus for absorbing as much power as possible, 266; would make an excellent governor, 266; long flat spring, tapering in thickness as well as in width, is the most scientific, 267; admirable instrument for ascertaining exact power exerted at end of screw shaft, 267.—Hartnell, W., Friction of new engine greatly in excess of friction after running short time, 267.—Paget, A., Water passing through instrument should be measured, 268.—Hawksley, T., Exact balance of force and resistance in dynamometer results in great precision of measurement, 268.—Froude, W., Means of changing water, for carrying off developed heat, 268; expulsion of air from the water used, 270; objection to any automatic governing apparatus, 271; form of dynamometer

# **DYNAMOMETER, MARINE-ENGINE (continued).**

spring, 272; tendency to "hunt" in Siemens' governor, 273; dynamometer very useful for determining friction of engines, not previously ascertained, 274.

**DYNAMOMETERS**, *Paper on Dynamometers, Friction Brakes, and other testing apparatus belonging to the Royal Agricultural Society of England*, by W. E. Rich, 1876, 199.—Great improvements in agricultural machinery and portable engines due to trials made by R. A. Society, 199.—Marine engines should be tried in the same manner, 200.—Most important instruments belonging to R. A. Society, 200.—Traction dynamometers, spring links, 200.—Difficulty of obtaining accurate reading of mean draught, 200.—Plough dynamometer, construction, 201.—Mode of calculation, 203.—Best way of testing springs, 204.—Calculation of correction for springs, 205.—Correction for friction and slackness of joints, 206.—Testing draught of ploughs, &c., 207.—Two equal runs in opposite directions to be taken when testing, 207.—Diagrams giving maximum strains tend to hinder experiments, although sometimes useful, 208.—Defects to be avoided in integrating dynamometer, 208.—Horse dynamometer for testing wheeled vehicles with shafts, 209.—Principle of working, 210.—Construction, 211.—Integrating and registering apparatus, 213.—Testing of mowing and reaping machines, 214.—Friction brake dynamometer, 215.—Simplicity of instrument and accuracy in testing, 215.—Description of 100 H.P. friction brake, 215.—Pendulum lever to maintain uniform frictional resistance, 216.—Rotary hand dynamometer, description, 219.—Mode of application, 221.—Large rotary dynamometers, 222.—Description of 20 H.P. rotary dynamometer, 222.—50 H.P. dynamometer, 225.—Early dynamometer designs, 226.

*Discussion.* — Bramwell, F. J., Simple mode of constructing an approximate dynamometer, 227; improvement in integrating apparatus by getting rid of rubbing motion of disc, 228.—Cowper, E. A., Thomson's integrating apparatus very good, although not quite perfect, 229; Ernst's better for taking up the motion, 229.—Paget, A., Advantage of ball apparatus over small integrating wheel, 230.—Darwin, H., Principle of proposed dead-weight rotary dynamometer obviating the use of springs, 231; description of dynamometer, 232; advantages, 233.—Carbutt, E. H., Good dynamometer required for railway purposes, 234.—Rich, W. E., Description of large traction dynamometer for Indian State Railways, 235.—Aveling, T., Great advantage in use of friction brake dynamometers for agricultural engines, 235.—Maw, W. H., Correct action of dynamometer depends upon mode of coupling the ends of brake strap to pendulum lever, 236; rim of brake wheel better flat than convex, 237; maximum power absorbed by brake, 237; tension of strap varies with each kind of

## DYNAMOMETERS (continued).

lubrication, 238.—Cowper, E. A., Slight error in lever of brake dynamometer, 238.—Adams, T., Action of springs of varying design, 238.—Rich, W. E., Peculiar angle at bottom of pendulum levers in Appold friction brake, 239; maximum power absorbed by brake without undue heating, 239; relative advantages of different forms of springs, 239.—Hawksley, T., Friction brakes do not give accurate results, 241; illustration of reason, 241; suggestion of practical test, 241.—Bramwell, F. J., Friction brake does not give absolute certainty in results, 242.—Cowper, E. A., Not stand-still friction, but running friction recorded by brake, 242.—Hawksley, T., Weight to be tested should attain uniform motion before bringing into play effect of vibration, 243.—Paget, A., Institution as a body should make experiments on accuracy of friction brake, 243.

DYNAMOMETER, 1879, 241, 256, 259, 262, 263, 500.

## E.

EAGER, J. E., elected Member, 1880, 9.

EAMES BRAKE on New York elevated railways, 1879, 208.

EASSIE, P. B., decease, 1876, 3.—Memoir, 20.

EASTON AND ANDERSON, Beams, Experiments to ascertain the Strength of Cast-Iron Beams for Beam-engines, 1882, 531.

Flanging Steel Plates, Experiments on Flanging Steel Plates cold by Hydraulic Pressure, 1882, 528.

EASTON, E., elected Member of Council, 1875, 34.—1877, 25.—1880, 24.

Bath, Floating Swimming, 1875, 153.

Water Supply from Chalk, *Paper* on the Yield of Wells sunk in the Chalk in the central portion of the London basin, 1876, 163.—Remarks, 169, 174.

EASTON, J. M., Dredger, Vertical-action, 1879, 559.

EASTWOOD, C., elected Member, 1884, 408.

EASTWOOD, J., decease, 1875, 3.—Memoir, 21.

EAVES, W., elected Member, 1875, 189.

EBBW VALE IRON WORKS, visited at Summer meeting, Cardiff, 1884, 359, 386-392.

ECKART, W. R., elected Member, 1878, 31.

ECONOMY OF RAILWAY WORKING, 1879, 96. *See* Railway Working.

EDMISTON, J. B., elected Member, 1883, 593.

EDMUNDS, H., vote of thanks for services as Treasurer, 1878, 500.

EDWARDS, F., elected Member, 1877, 165.

EDWARDS, R., elected Member, 1880, 9.

EJECTOR, AIR, 1877, 332.

EJECTOR, WATER, 1874, 292; 1877, 319, 336.

ELECTION, Council, 1874, 26.—1875, 34.—1876, 26.—1877, 25.—1878, 28.—1879, 36.—1880, 24.—1881, 30.—1882, 32.—1883, 53.—1884, 21.]

Members, 1874, 27, 55, 101, 256.—1875, 35, 65, 189, 313.—1876, 27, 57, 197, 347.—1877, 26, 71, 165, 299.—1878, 30, 107, 293, 558.—1879, 37, 155, 397, 583.—1880, 9, 185, 310, 489.—1881, 9, 163, 408, 624.—1882, 15, 145, 254, 475.—1883, 33, 179, 309, 593.—1884, 1, 79, 198, 408.

Secretary, W. R. Browne, 1878, 29.—A. Bache, 1884, 78.

Treasurer, T. Druitt, 1878, 560.

ELECTRIC APPARATUS FOR RAILWAY BRAKES, automatic, 1878, 554.

ELECTRICITY FOR COAL MINING, *Paper* on the Application of Electricity to the Working of Coal Mines, by A. C. Bagot, 1883, 421.—Electric signalling in mines, 421.—Wires, 422.—Batteries, 423.—Electric signalling at Cannock and Rugeley Collieries, 424.—Engine-plane signals, 426.—Electric recording anemometer, 427.—Telephone for pump-valves, 427.—Surface illumination by electric light, 428.—Underground ditto, 428.—Advantages of safety-lamps, 429.—Electricity for underground haulage, 430.—Recapitulation, 430.

*Discussion.*—Tresca, H., Electrical transmission of power in France, 432; sources of loss of power, 432; useful effect, 433; electrical haulage, 434.—Cochrane, C., Electric lighting for tunnels, 434; winding by dial-indicator, 434.—Hedges, K. W., Electric lamp for underground working, 435; underground haulage by electricity, 435.—Bagot, A. C., Electric lamp does not indicate presence of gas, 436; distance-indicator for winding, 436; compressed-air more applicable underground than electricity, 436; advantage of electric signalling, 437.

ELECTRIC LIGHTING, *Paper* on Lighting by means of Electricity, by H. Fontaine, 1878, 529.—Increase in use of electric light, 529.—Electric light will not interfere with gas or candle light, 530.—Four points for consideration, 530.—Various forms of electric machines used, 530.—Advantages and dimensions of Gramme machine, 530.—Illuminating power under different circumstances, 531.—Choice of machine does not depend solely upon bulk and driving power, 532.—Small proportion of cost of motive power to whole cost, 532.—Great importance of cheapness and durability, 533.—Comparative cost of electric light and of gas at M. Manchon's works, Rouen, 534.—Report on electric light at these works, by M. Delahaye, 535.—Cost and capabilities of Gramme machine, 536.—Carbon rods, 537.—Regulators, 538.—Conducting wires, 538.—Description of Jablochhoff candle, 538.

*Discussion.*—Shoolbred, J. N., Gramme machine has advantage of being very versatile, 540; objections to Jablochhoff candles, 540; perfect

## ELECTRIC LIGHTING (continued).

steadiness has not yet been obtained by Jablochkoff candles, 541; length of carbons in Siemens lamp, 542; photometric measurements show that the best arrangement of carbon points has not yet been determined, 542; Lontin system appears successful in Paris, 543.—Powell, T., Results of working with Gramme machine, 543; length of carbons, 543.—Robinson, J., Regrets absence of Dr. Siemens, 544.

ELECTRIC LIGHTING, *First Paper* on Electric Lighting, by J. Hopkinson, Jun., 1879, 238.—Object to ascertain what various dynamo-electric machines can do, and what power they absorb, 238.—Relation between electro-motive force and current must be known in each case, 239.—Experiments on a Siemens machine; apparatus employed, 240.—Determination of resistances, 244.—Method of calculation, 245.—Results, as shown by curve, 246.—Comparison with other results, 247.—Explanation on Weber's theory, 248.

*Discussion.*—Hopkinson, J., Explanation of point of inflection in curve, 250.—Preece, W. H., Electricity a new subject for engineers, 250; importance of investigating electric currents, 251; efficiency of machines might still be improved, 252; speed of working is function of machine only, 252; small proportion of energy of machine reappears as light, 253; author's method of measuring currents is the correct one, 253.—Rayleigh, Lord, Cause of curve deviating from straight line, 254.—Cowper, E. A., Peculiarity in curve due to difference between rising and falling currents, 254; laminated magnets should be used, thereby lessening residuary magnetism, 255.—Adams, W. G., Another way of representing the curve, 256; analogy between flow of water, electricity, and heat, 257.—Olrick, L., Engines ordered by Government for driving electric machines, 258.—Kennedy, A. B. W., How far can dynamometer be trusted, 259.—Hopkinson, J., Curve agrees with Weber's theory of induced magnetism, 260; effect of residual magnetism, 260; advantage of laminated magnets, 260; reasons for preferring his own way of representing the curve, 261; accuracy of dynamometer, 262; another form of dynamometer, designed by Mr. Parsons, 263.—Cowper, E. A., Magnets might be magnetised by a separate machine, 264.—Hopkinson, J., That would introduce another variable, 264.—Robinson, J., Electricity has been studied by engineers long ago, 264.

ELECTRIC LIGHTING, *Second Paper* on Electric Lighting, by J. Hopkinson, Jun., 1880, 266.—Author's experiments with Siemens dynamo-electric machine, 266.—“Critical current,” 267.—German experiments with Gramme machine, 267.—Dr. Siemens' and author's experiments with Siemens machines, 267–8.—Time required to develop current in Gramme machine, 269.—Brightness of electric arc, 269.—Intensity different in different directions, 269.—Comparison with standard candle and lamp, 270.—



## ELECTRIC LIGHTING (continued).

Photometer for powerful lights, 270.—Efficiency of electric arc, 272.—Occasional instability of electric light, 273.—Use of shunt electro-magnet, 273.—Measurement of horse-power developed in electric arc, 274.

*Discussion.*—Shoolbred, J. N., Experiments at Silvertown with Gramme machine, 274-6; inconvenience of photometric methods hitherto used, 277; measurement of horse-power in electric arc, 277; increased regularity by division of current, 277.—Crompton, R. E. B., Advantages of long and short electric arcs, 277; regulation of lamps for getting stability of light, 278; new photometer for practical measurements, 279; measurement of lights of different colour, 280; burning of regulating lamps in series, 280.—Preece, W. H., Shadow photometer independent of colour, 280; difficulty from want of uniformity in human eye, 281.—Perry, J., Concave lens compared with convex for photometer, 282; adaptation of photometer for all directions of light, 282.—Hedges, K., Objectionable colour can be neutralised by mixture in carbons, 282.—Hopkinson, J., Inflection in Mr. Gray's curve due to error of observation, 283; electrical resistance in German experiments, 283; critical current, 283; explanation of rule for horse-power in electric arc, 283; comparison of Gramme and Siemens machines, 283; trouble with electric lights is largely due to bad governing of engines. 284; adaptation of photometer to lights at different angles, 284; comparison of electric light and standard candle in respect of colour, 285; shadow photometer not entirely independent of colour, 285; advantage of convex lens in preference to concave, 285.

ELECTRIC LIGHTING of Birmingham Town Hall, at Autumn meeting, 1883, 597, 598.

ELECTRIC LIGHTING at Menier's Chocolate Works, 1878, 553.

ELECTROGEN, Hannay's, 1884, 335, 342, 348, 356. *See* Boiler Corrosion.

ELECTRO-MAGNETIC CHUCK, 1875, 38. *See* Chuck, Electro-Magnetic.

ELECTRO-MAGNETS. Application of Electro-Magnets to the working of Railway Signals and Points. 1884. 444. *See* Railway Electric Signals.

ELLACOTT, R. H., elected Member, 1879, 38.

ELLINGTON, E. B., elected Member, 1875, 65.

Boiler and Engine, High-Pressure, 1877, 146.

Disintegrator, Vapart, 1878, 502.

Gauge, Standard, for High Pressures, 1880, 474.

Hydraulic Machinery, Toulon, 1878, 383.

Lifts, *Paper* on Hydraulic Lifts for passengers and goods, 1882, 119.—Remarks, 167, 176.

Power Transmission, 1881, 99.

Pressure-Intensifying Apparatus, 1878, 59.

Pump, Greindl Rotary, 1878, 464, 465.

Water-Power Engines, 1879, 490.

ELLIOTT, H. J., elected Member, 1883, 593.

ELLIOTT, T. G., elected Member, 1882, 254.

ELLIOTT, T. M., elected Member, 1877, 165.

ELLIS, O. W., elected Member, 1880, 489.

ELSWICK ENGINE AND ORDNANCE WORKS, visited at Newcastle meeting, 1881, 597.

ELWELL, T., decease, 1881, 11.—Memoir, 4.

Expansion Gear, Correy, 1878, 523.

ELWELL, T., JUN., elected Member, 1875, 314.

ELWIN, C., elected Member, 1878, 558.

Dock, Victoria Floating. *Paper* on a Floating Dock upon an improved system at the Victoria graving docks, 1878, 139.—Remarks, 176, 182.

ENGINE AND BOILER, HIGH-PRESSURE 1877, 117. *See* Boiler and Engine, High-Pressure.

ENGINE, BROTHERHOOD'S THREE-CYLINDER, 1874, 173, 183, 184, 224; 1875, 126, 130.

ENGINE BEAMS, Experiments on Strength of, 1882, 531. *See* Beams.

ENGINEERING AND SHIPBUILDING WORKS, visited at Newcastle meeting, 1881, 595, 610, 615.

ENGINEERING IN LEEDS, *Paper* on the History of Engineering in Leeds, by A. H. Meysey-Thompson, 1882, 266.—Early history to eighteenth century, 266.—Matthew Murray's inventions in flax machinery, 267.—Wesley and Lawson's screw gill, 267.—Murray's mill engines, 268.—Invention of double-cylinder engine, D slide-valve, &c., 268.—Blenkinsop and Killingworth locomotives, 268.—Date-chart of commencement of Leeds trades, 269.—Textile machinery, 269.—Locomotive and marine engines, 269.—Heavy engineering tools, 270.—Machinery for supply of war material, 270.—Locomotives, tramway engines, and agricultural machinery, 271.—Fixed engines, 271.—Machine-made clothing, 272; hats and caps, 273; boots and shoes, 273; cut nails, 273.—Iron making, early history, 274.—Manufacture of Best Yorkshire iron, 275.—Collieries, 275.—Map of coal and iron measures, 276.—Mechanical appliances for collieries, 276.—Leeds waterworks, 276.—Scientific education, 277.

ENGINE, HESLOP, 1879, 85. *See* Heslop Engine.

ENGINE RECORDER, *Paper* on the Moscrop Engine Recorder and the Knowles Supplementary Governor, by M. Longridge, 1884, 150.—Objects of the two instruments, 150.—Unsteady turning of engines, 150.—Calculation is tedious and often delusive, 151.—Description of Recorder, 151.—Recording apparatus, 151.—Governor, 152.—Marker, 152.—Paper tape, 152.—Indications of irregularity, 153.—Permanent record of engine performance, 154.—Illustrative examples, 154.—Errors from construction of instrument, 155.—Slipping of driving band, 155.—Momentum of driving pulley and governor, 156.—Friction, 156.—Slow motion of tape, 156.—Supplementary Governor, 157.—Defects of parabolic and other centrifugal governors, 157.

## ENGINE RECORDER (continued).

—Length of rod connecting governor with throttle-valve is adjusted automatically by supplementary governor, 158.—Efficiency proved by recorder diagrams, 159.

*Discussion.*—Moscrop, J. B., Specimens of recorder diagrams, 160.—Richardson, W., Performance of recorders, 160.—Fletcher, L. E., Good field for operations of recorders, 160.—Platt, J., Defect in driving by belt, 160.—Schönheyder, W., Difficulty from backlash of gearing, 160; recorder designed only for slow-moving engines, 161; supplementary governor might supersede larger governor, 161.—Anderson, W., Relation between degree of expansion and weight of reciprocating parts, 162; mathematical calculation might be tested by recorder, 162.—Longridge, M., Failure of main engine-shafts, due to variations of angular velocity, 163; calculation of period of oscillations, 164; periodicity of vibrations is neutralised by coupling two engines at right angles, 166; driving band with butt joint, 166; supplementary governor does not always supersede ordinary governor, 166.

ENGINE WORKS visited at Belgian meeting. Ateliers de la Meuse, 1883, 513, 534.—Carels', 517, 568.

ENGINES, COMPOUND LOCOMOTIVE, 1879, 328.—Fireless, 610. *See* Locomotives.

ENGINES, MARINE, 1881, 449. *See* Marine Engine.

ENGINES, PUMPING, DIRECT-ACTING, *Paper* on Direct-Acting Pumping Engines and Pumps for high lifts in mines, by H. Davey, 1874, 258.—Various constructions of pumping engines for draining mines, 258.—Single-acting Cornish beam engine, 258.—Water load per sq. in. of steam-piston area, 259.—Cornish Bull engine, 259.—Rotary double-acting beam engine, 259.—Speed of steam-piston, 259.—Horizontal rotary geared engine, 260.—Compound differential engine, 260.—Action of the differential valve-gear, 261.—Compound differential pumping engine at Lambton Colliery, 262.—Self-acting adjustment of the cut-off point in accordance with each variation in load, 263.—Freedom from shocks in the pumps, 263.—Compound pumping engines, 265.—Limited expansion in a single cylinder, 266.—Pumps and pitwork, Cornish system, 267.—Bucket lift, 268.—Inverted plunger, 268.—Hollow plunger, 268.—Engine placed underground and forcing water to the surface direct, 268.—Construction of valves, 269.—Differential pumping engines at Clay Cross Colliery, 270.—Condensation of steam in taking supply down the pit, 270.

*Discussion.*—Davey, H., Action of compound differential engine, 271.—Menelaus, W., Advantage in Cornish engine for permanent pumping as well as sinking, 272.—Davey, H., Advantages of compound differential engine in removing difficulties of pumping whilst sinking a pit, 272; self-acting control of engine when pump clack is gagged, 272.—Menelaus, W., Direct-

# ENGINES, PUMPING, DIRECT-ACTING (continued).

acting engine would require additional temporary pumping apparatus for sinking, 273.—Markham, C., Cornish pumping engine works best, 274; plunger pumps preferable to piston pumps, 275.—Cowper, E. A., Action of differential valve motion, 275; compound engine better for large expansion than single cylinder, except in some Cornish engines, 275; pumping engine worked more economically and safely at bottom of pit, 276; result of experiments on condensation of steam in pipes, 276.—Head, J., Comparative evaporative efficiency of boilers with or without non-conducting covering, 277.—Davey, H., Direct-acting engine could remain at surface if desired, 277; speed of water through pump valves, 278; hydraulic pumping engine used under water at bottom of pit for raising water to main pumping engine, 278; action of differential valve-gear in making engine safe for working with a riding column of water, 278; amount of loss from condensation in steam pipes carried down a pit, 279.—Bramwell, F. J., Ingenious mode of controlling extreme speed of engine by reversal of the steam, 279.

ENGINES, WINDING, DIRECT-ACTING, *Paper on Direct-Acting Winding Engines for Mines*, by G. H. Daglish, 1875, 217.—Description of single-cylinder vertical winding engine, 217.—Coupled pair of vertical winding engines, 218.—Prejudice against horizontal cylinders that they are worn oval by weight of piston, 219.—Horizontal winding engines at Rose Bridge Colliery, 219.—Speed of winding, 221.—Back piston-rods and slides not necessary, and abandoned, 221.—Coupled horizontal engines working Pemberton Colliery, 221.—Counterbalancing required on account of great variation in power employed, 223.—Conical drums, external and internal, 223.—Counterbalances, 225.—Tables giving particulars of colliery winding engines, 227.

*Discussion.*—Head, J., Back piston-rod worse than useless, 233; prevention of oval wear of cylinder, 233.—Reynolds, E., Back piston-rod not necessary when piston has plenty of bearing surface, 233; modern winding engines made excessively large for quick starting, causing greater strain on rope, 234; large-sized drum and pulleys reduce the wear arising from reversing bend of rope, 234.—Walker, B., Great weight of drum in modern engines, advantageous as a fly-wheel, 234; back piston-rod useless, but piston-rod made flat at underside with advantage, 235.—Rye, W., Back piston-rod may be advantageously abandoned, 235.—Davey, H., Expansive working in winding engines, 235; wearing oval of horizontal cylinders avoided by good metal and large piston surface, 236; back piston rod worse than useless, 236; difficulty in keeping double-beat valves and seats steam-tight when made of different metals, 236.—Lawrence, H., Prevention of leakage from expansion in double-beat valves,

# ENGINES, WINDING, DIRECT-ACTING (continued).

236; greater durability of ropes on conical drums than on flat drums, 237; many condensing winding engines working efficiently in Durham, 237.—Hall, W. S., Pit-head pulley if made too large acts as flywheel and wears rope by over-running, 238.—Cochrane, C., Wear of horizontal cylinders by bearing weight of piston, 238.—Adamson, D., Back piston-rod should not be used, 239; composition of metal best suited for cylinders, 239.—Howe, W., Wear of horizontal cylinder with back piston-rod, 240; construction of packing rings, 240; prevention of leakage from expansion in double-beat valves, 240.—Claridge, T., Difficulty overcome of unequal expansion in double-beat valves, 241.—Watkin, W. J. L., Long duration of ropes attributable to careful make of grooves on drums, 241; rope passing under winding drum wears out sooner than rope passing over, 242.—Bryham, W., Greater wear and tear of flat rope with flat winding drum than of round rope with conical drum, 242; great gain in durability of rope from wood grooves on drum properly fitting each convolution of rope, 242; distance for stopping cage in pit, 243; back piston-rod found no advantage and removed, 243.—Daglish, G. H., Maximum speed in shaft, 243.—Waddle, J. R., Slide-block at end of back piston-rod found useful for carrying weight of piston, 244.—Daglish, G. H., Expansion valves not used for winding engines, 244; cylinder not worn oval when working without back piston-rod, 244; double-beat steam valves and seats of gun-metal satisfactory, 244.—Bramwell, F. J., Application of condensing engines to winding, 245; back piston-rod better omitted in horizontal engines, 245; means of preventing over-winding important to be considered, 246.

ENGINES, TRACTION, Working of, in India, 1879, 494. *See* Traction Engines.

ENGINES, WATER-POWER, with variable stroke, 1879, 484. *See* Water-Power Engines.

ENGINES, WATER-PRESSURE, for mining purposes, 1880, 245. *See* Water-Pressure Engines.

ERIMUS STEEL WORKS, 1881, 627. *See* Steel Plant.

ETHERINGTON, J., elected Member, 1884, 408.

EVANS, D., elected Member, 1884, 198.

EWEN, T. B., elected Member, 1881, 9.

EXCAVATORS, Bull's and Bruce's, 1879, 555, 559.—Fouracres, 534.—Milroy's, 562. *See* Dredger.

EXCAVATION OF CHANNEL TUNNEL by Automatic Hydraulic System, 1882, 440. *See* Tunnel, Channel.

EXCURSIONS at Summer Meetings:—

Cardiff, 1874, 162, 234.

Manchester, 1875, 307.

Birmingham, 1876, 327.



## EXCURSIONS (continued).

- Bristol, 1877, 296.
- Paris, 1878, 546.
- Glasgow, 1879, 567.
- Barrow-in-Furness, 1880, 478.
- Newcastle-on-Tyne, 1881, 595.
- Leeds, 1882, 451.
- Belgium, 1883, 511.
- Cardiff, 1884, 356.

EXHAUST-STEAM INJECTOR, 1884, 167. *See* Injector.

EXHIBITION, *Report on the North-East Coast Exhibition of Marine Engineering*, &c., by J. Head and G. B. Rennie, 1882, 472.

EXPANSION CURVE FOR STEAM, true theoretical, 1877, 289.

EXPANSION GEAR, AUTOMATIC, *Paper on Governing Engines by Regulating the Expansion*, by W. Hartnell, 1882, 408.—Advantages of automatic expansion gear, 408.—Saving of fuel, 408.—Estimate of steam saved, 409.—Form of indicator diagrams, 409.—Economy of steam with various cut-off, 409.—Ditto with variable load, 410.—Prompt governing, 410.—Perfect governing, 411.—Retardation from storage, and from friction, 412.—Governor power, 415.—Retardation from friction, and from storage and friction combined, 416.—Special automatic expansion gear, 416.—Governor applied to separate cut-off valve, 417.—Ditto to ordinary slide-valves, 418.—Automatic expansion regulator, 420.—Governor power obtained with springs, 420.—Sensitiveness, 421.—Screwing up springs, 421.—Angle of bell-cranks, 423.—Applications of governors, 425.—Indicator diagrams, 425.—Notes: position and adjustment of eccentrics, 425; size of spiral springs, 426; travel of governor balls, 426; size of fly-wheel, 427; calculation of governor springs, 428; extreme speeds due to springs, 430.

*Discussion.*—Hartnell, W., Description of governors exhibited, 431.—Turner, F., Experience in manufacturing these governors, 431.—Maw, W. H., Admirable working of expansion regulator, 432.—Shaw, H. S. H., Economy due to automatic expansion, 432; regulation of speed by automatic expansion or by fly-wheel, 433.—Halpin, D., Governor power for moving expansion gear, 434.—Bale, M. P., Durability of governor springs, 434.—Paget, A., Experience with reciprocating springs, 434.—Crampton, T. R., Range of expansion, 435; wire-drawing, 435.—Hartnell, W., Indicator diagrams produced without throttle-valve, 436.—Crampton, T. R., Wire-drawing by slide-valve, 436.—Hartnell, W., Interdependence of fly-wheel and governor, 437; resistance to be overcome by governor, 437; durability of springs, 438; limit of expansion, 438.—Westmacott, P. G. B., What effect if governor spring broke, 438.—Hartnell, W.,

## EXPANSION GEAR (continued).

Steam shut off by spring breaking, 439 ; diagrams illustrating conclusions, 439.

EXPANSION GEAR, CORREY, *Paper* on vertical compound engines fitted with Correy's variable Expansion Gear, by T. Powell, 1878, 504.—Construction of steam-engines at Rouen, 504.—Early Woolf engines with ordinary slide-valve, 504.—Woolf engines with expansion in small cylinder, 506.—Variable expansion by the governor on Correy system, 507.—Trial of Woolf engine of M. Lavoisier, with expansion by lap-valve, 511.—Trials of engine of M. Fauquet Lemaitre with Correy expansion gear, 513.—Trial of engine of MM. Waddington with Correy expansion gear, 515.—Conclusions, 521.

*Discussion.*—Robinson, J., Comparison desirable of this gear with other systems, 523.—Elwell, T., Contrivance appears very complicated, 523.—Robinson, J., Complication inevitable if the cut-off is so early as to allow of great expansion, 523.—Hawksley, C., Description of pumping engines and expansion gear at Derby water works, 523.—Markham, C., Small cylinder should be small enough to do without cut-off, 524.—Platt, J., Motion is really very simple, 524.—Hunter, W., Had engine of Messrs. Windsor the same cut-off as that described, 525.—Powell, T., Knows no variable cut-off on vertical engine so simple as this, 525 ; great exaggeration as to influence of length of ports, 526 ; desirable to have automatic expansion gear in order to obtain regularity of speed, 526 ; evils of having no cut-off in small cylinder, 526 ; Windsor's engine not so easily regulated, 527.—Robinson, J., Great aim was to get a valve-gear simpler than the Corliss, and equally effective, 528.

EXPANSION IN LOCOMOTIVES. *See* Locomotives.

EXPANSION, VARIABLE AUTOMATIC, *Paper* on the economy of Variable Automatic Expansion in steam engines, by J. C. Fell, 1877, 276.—Theoretical gain from high degrees of expansion is considerably reduced in practice by cooling from extended surface, 276.—Practical useful limit is reached with moderate expansion, 277.—Means of determining limit of economy in expansive working, 278.—Improved economy from variable automatic expansion, 278.—Advantage of true expansion over throttling, 279.—Description of Rider's variable automatic expansion gear, 280.—Successful practical results of working, 281.

*Discussion.*—Froude, W., True limit of economy in expansion, 283.—Hartnell, W., Practical limit of economy by expansion, 284 ; economy of fuel with a variable cut-off, 285 ; cut-off usually too early with fixed gear, 285.—Oughterson, G. B., Automatic cut-off gives perfect command over regularity of work in cotton mills, but is not suited for all classes of engines, 286.—Powell, T., Automatic gear is economical where load

## EXPANSION, VARIABLE AUTOMATIC (continued).

varies continually, but of little benefit with a constant load, 286.—Rich, W. E., Risk of leakage with cylindrical slide-valve, 287; movable eccentric required for a good range of expansion, 287.—Hartnell, W., Variable expansion gear ought also to be automatic, 288.—Cowper, E. A., Theoretical diagram of true expansion curve for steam, 289; stationary expansion-link alters both the stroke and the lead, 290; importance of steam-jacket to prevent loss by condensation, 291.—Paget, A., Loss by leakage of cylindrical cut-off valve likely to exceed the gain by automatic motion, 291.—Braham, P., Value of fuel depends upon mode in which it is used by stoker, 291.—Morgans, T., Indicator diagram shows throttling in return stroke, 291.—Fell, J. C., Practical limit of final steam pressure in expanding, 292; advantage of automatic expansion gear in giving full steam whenever required, 293; no leakage of cylindrical valve after five years' working, 294.

EXPANSIVE WORKING of Winding Engines, 1875, 235, 244.

EXPLOSIVE MIXTURES of gas and air for Gas Engines, result of experiments by H. Tresca, 1875, 205, 210, 216.

EXTENSOMETER for measuring Increase of Length in testing by Tensile Strain, 1878, 256.

EYTH, M., Iron and Steel for Boilers, *Paper* on experiments referring to the use of Iron and Steel in high-pressure Boilers, 1879, 268.—Remarks, 303, 325, 326.

## F.

FAJJA, H., Bath, Floating Swimming, 1875, 149.

Cement, Portland, *Paper* on the Manufacture and Testing of Portland Cement, and the machinery used in its production, 1875, 46.—Remarks, 55, 60.

FAIRBAIRN, SIR W., notice of decease, 1874, 253.—Resolution of meeting, 255.—Memoir, 1875, 22.

FAIRHOLME, Capt. C., elected Associate, 1883, 310.

Brake, Automatic Screw-Brake, 1882, 512.

Brakes, Automatic action, 1880, 139.

FANS. *See* Ventilators.

FARCOT, J. J. L., elected Member, 1875, 314.

FARCOT, P., elected Member, 1880, 185.

FARQUHAR FILTERING APPARATUS, 1881, 145-162. *See* Filter.

FARQUHAR, J. F. C., Filter, Farquhar, 1881, 159-160.

FARRAR, S. H., elected Member, 1881, 624.

FAVIELL, S. C., decease, 1875, 3.—Memoir, 24.

FAWCETT, T. C., elected Member, 1882, 254.

FAY, C., Brakes, Effect of, upon railway trains, 1878, 628.

FEARFIELD, J. P., elected Member, 1884, 79.

Locomotive Running Shed, 1884, 253.

FEED-WATER HEATER AND FILTER, *Paper* on a Feed-Water Heater and Filter for Stationary and Locomotive Boilers, by G. S. Strong, 1881, 539.—Soluble and insoluble substances in water, 539.—Temporary and permanent hardness of water, 540.—Table of solubility of sulphate of lime at different temperatures, 541.—Principle of feed-water heater, 541.—Description of heater, 542.—Filter, 543.—Adaptation for condensing engines, 543.—Adaptation to locomotive boilers, 544.—Examples of application, 544.

*Discussion.*—Strong, G. S., Process of blowing-off for cleaning filter, 545; simpler arrangement of tubes, 545; application to locomotives in England, 546.—Richardson, W., Filtering sewage water for feeding boilers, 546.—Greig, D., Extra heating of feed-water seems right course, 547.—Rich, W. E., Exhaust pipe not hot enough to heat hot-well water, 547.—Abbott, T., Mode of withdrawing filter from casing, 547.—Cowper, E. A., Use of filter with bad water, 548.—Head, Jeremiah, Is precipitation of all dissolved substances by heat a fact, 548.—Cochrane, C., Condensed water may be used again with caustic soda, 549.—Pattinson, H. L., Insolubility of sulphate of lime in hot water, 549.—Strong, G. S., Use of water from hot-well, 550; separation of sulphate of lime, 550; prevention of corrosion inside heater, 550; mode of changing the filter, 551.

FEEDER FOR STEAM BOILERS, Fromentin Automatic, 1882, 479. *See* Boiler Feeder.

FEENY, V. I., elected Member, 1882, 15.

FELL, J. C., elected Member, 1876, 27.

Accidents, Mine, Mechanical Appliances for, 1877, 333.

Expansion, Variable Automatic, *Paper* on the economy of Variable Automatic Expansion in steam engines, 1877, 276.—Remarks, 282, 292.

Friction Experiments, 1884, 33.

Iron and Steel, Physical condition of, 1884, 57.

FENTON, J., elected Member, 1877, 71.

FERDINAND LOUSBERGS COTTON MILLS, visited at Belgian meeting, 1883, 517.—Description of Works, 564.

FERGUSON, W., elected Member, 1881, 163.

FERNIE, J., Power Transmission, 1881, 93.

Steel, Chernoff's papers, 1880, 240.

FOLKES, M. W. B., elected Graduate, 1875, 190.

FIELDEN, J. P., elected Member, 1884, 79.

FIELDING, J., elected Member, 1874, 256.

Cutting of Metals, 1883, 258, 261.

FILTERS, Bag, Centrifugal, Disc, Sponge, Stone. *See* Bath, Floating Swimming, 1875, 134.

FILTER, *Paper* on the Farquhar Filtering apparatus, by H. Chapman, 1881, 145.

—Difficulties of mechanical filtration for sewage, 145. — Principle of continuous removal of fouled filtering surface, 146.—Description of Farquhar filter, 146.—Results of experimental working, 148.—Filtration of sewage and night-soil in Paris, 148.—Filtration of sugar juice, 149.—Filtration of turbid river water, 150.—Application of system to sewage, 150:—to waterworks, 151:—to manufactures, 153. — Advantages of sawdust as filtering material, 153.

*Discussion.*—Hawksley, T., Slow filtration essential for potable water, 155; filtration partly chemical, 156; rapid filtration applicable for sewage &c., but not for waterworks, 156.—Crampton, T. R., Sewage must be pumped into filtering apparatus, 157.—Hawksley, T., Filtration under pressure not new, but continuous scraping of filter-bed is, 157; sawdust must not impart taste or smell to water, 157.—Newman, F., Filtration of flood water containing clay, 157.—Hawksley, T., Slow filtration necessary for perfect clearness, 158.—Newman, F., Objections to slow filtration, 158.—Platt, S. R., Has filter been applied to water from coal-washing, 159.—Cowper, E. A., Is apparatus at work at Barclay's brewery, 159.—Farquhar, J. F. C., Not now at work, and of different construction, 159.—Cowper, E. A., Filtration of turbid river water, 159.—Farquhar, J. F. C., Success of rapid filtration, 159; difference between sand and sawdust, 160; inodorous sawdust for filtering potable water, 160; arresting of suspended clay matter by sawdust filter, 161; filtration of water from coal-washing, 161; depth of filter-beds, 161.—Hawksley, T., Shingle under sand filter-beds is only to support sand, 161.

FILTER AND HEATER FOR FEED-WATER, 1881, 539. *See* Feed-Water Heater and Filter.

FILTRATION OF WATER, real action by attraction of particles, 1875, 154.

FIRE EXTINCTION, Injector Hydrants for, 1879, 364. *See* Injector Hydrant.

FIRE-FEEDER, MECHANICAL, *Paper* on the Frisbie Mechanical Fire-Feeder and Grate for boilers and furnaces. by B. P. Walker, 1876, 318.—Object of apparatus, 318.—Construction and action of fire-feeder, 318.—Means of removing incombustible matter from grate, 319.—Advantages of firing by inserting fuel from beneath, 319.—Application and satisfactory results of working, 320.

*Discussion.*—Walker, B. P., Self-acting apparatus for feeding hopper, 321; disadvantage in applying fire-feeder to Cornish boiler, 321.—Olrick, L., Admission of air above grate for burning smoke, 321; removal



## FIRE-FEEDER, MECHANICAL (continued).

of clinkers from grate, 322.—Smith, M. H., Loss of coal from firing too fast, 322; durability of fire-bars with more intense combustion, 322.—Bramwell, F. J., Early plan of feeder for introducing coal below fire, 323 advantage of firing from below, 324.—Walker, B. P., Satisfactory consumption of smoke, 324; power required for charging grate, 325; great durability of fire-bars, 325; cost of fire-feeder, 326; advantage in breaking up clinkers on top of fire, 326; extensive application to glass houses, 326.

FIRELESS LOCOMOTIVES, 1879, 610.—1880, 37. *See* Locomotives.

FIRTH, S., Brakes, Effect of, upon railway trains, 1879, 215.

FIRTH, W., elected Member, 1874, 256.

Compressed-Air Machinery, 1874, 220.

FISHER, B. S., decease, 1884, 3.—Memoir, 62.

FISHER, G., elected Member, 1884, 198.

FISHER, H. O., elected Member, 1884, 79.

FLANGING MACHINE, HYDRAULIC, 1874, 170.

FLANGING STEEL PLATES, Experiments on Flanging Steel Plates cold by Hydraulic Pressure, by Messrs. Easton and Anderson, 1882, 528.—Description of moulds, 528.—Plates of Landore Siemens S.S. quality, 528.—Results of flanging annealed and unannealed plates, 528.

FLANNERY, J. F., elected Member, 1877, 71.

Boiler and Engine, High-Pressure, 1877, 141.

High-Pressure Vessels, 1878, 284.

FLATEAU, C. L., Portable Railways, 1884, 146.

FLAX AND TOW MILLS, La Liève, 1883, 517, 565.

FLEMING, W., Jute, *Paper* on the manufacture of Jute, 1880, 380.—Remarks, 392, 393.

FLETCHER, D. H., elected Member, 1882, 15.

FLETCHER, G., elected Member, 1883, 309.

FLETCHER, H. A., memoir, 1884, 472.

Heslop Engine, *Paper* on the Heslop Engine, 1879, 85.—Remarks, 93, 94. Rules, 1879, 42.

Patent Laws, 1876, 191.

FLETCHER, JAMES, SEN. (Manchester), decease, 1882, 17.—Memoir, 5.

FLETCHER, JAMES, JUN. (Manchester), decease, 1875, 3.—Memoir, 24.

FLETCHER, L. E., Boiler, Lancashire, *Paper* on the Lancashire Boiler, its construction, equipment, and setting, 1876, 59.—Remarks, 82, 121.

Engine Recorder, 1884, 160.

Riveted Joints, 1881, 274, 279, 280, 282.

FLEUSS APPARATUS for Working in Irrespirable Gases, 1882, 187.—Oxy-hydrogen safety lamp, 1882, 195. *See* Diving Appliances.

FLEUSS, H. A., Diving Appliances, 1882, 190, 191, 195, 197, 198.

FLOATING DOCK, 1878, 139. *See* Dock, Victoria Floating.

FLOATING SWIMMING BATH, 1875, 134. *See* Bath, Floating Swimming.

FLOW OF SOLIDS, *Paper* on further applications of the Flow of Solids, by H. Tresca. 1878, 301.—Two distinct periods of elasticity in bodies, 301.—Third period, that of fluidity, 302.—Jets of solid matter, 302.—Flow of solids in punching, 303.—American punched nuts, 305.—Forging, 306.—Fibrous structure of iron, 307.—Heat developed in forging, 311.—Experiments with iridised platinum, 314.—Stamping, 317.—Planing, 321.—Characteristics of cuttings from lathes and planing machines, 322.—Similar phenomena in geology, 327.

*Discussion.*—Robinson, J., Treatment of the subject might be called "mechanical analysis," 328.—Blake, W. P., Ellipsoidal pebbles found in United States, 328; fracture and regelation not necessary to flow of ice, 329; flow of solids might include every substance, 330.—Bell, I. L., Absence of striæ in Swedish iron due to mode of manufacture, 331; skeleton left after treatment by chlorine is not pure silica, 331.—Williams. R. P., Continuous crossing made by hydraulic pressure, 332; steel rails might be cold-rolled, 333.—Paget, A., Question whether iron were crystalline or fibrous, 334; pitch, as illustrating flow of solids, 334.—Hopkinson, J., Jun., How far are phenomena of flow of solids dependent on time, 335; distinctions between very viscous fluid and solid body, 336; temporary flow of solids, 336.—Bell, I. L., Fibre in iron is produced by drawing out crystals, 337; cold-rolling process has been tried, 338.—Tresca, H., Flow of solids as shown in fire-clay and in schist, 339; explanation of phenomenon of faults, 339; ice is a plastic material that can be moulded in all directions, 340; vitreous and brittle substances are only so relatively to the medium in which they are placed, 341; iron is made impure by either oxide or silicate, 341; changes produced in iron by rolling or hammering when cold, 341; fibrous structure of wrought iron, 342; cause of fibrous iron becoming apparently crystalline, 343; oxidisation has not same effect on iron as on steel, 343; time is an important element in changing form of solid substance, 343; deformation of material under slow pressure and under sudden blow is not identical, 344; in bringing a mass from one shape to another it is necessary the mechanical work should be properly expended, 344.

FLOW ROUND RIVER BENDS, by J. Thomson, 1879, 456.—Theory of flow of water round river bends, 456.—Verification of theory by experimental apparatus, 459.

FLUID COMPRESSED STEEL, Whitworth process, 1880, 171, 179, 180, 181. *See* Steel, Fluid-Compressed, and Guns, 1875, 268.

FONTAINE, H., Electric Lighting, *Paper* on Lighting by means of Electricity, 1878, 529.

FONTAINE, M. BERRIER-, elected Member, 1878, 293.

Hydraulic Machinery, Toulon, *Paper* on the Hydraulic Machinery in the iron shipbuilding department of the naval dockyard at Toulon, 1878, 346.

FORBES, D. M., elected Member, 1882, 15.

FORBES, D. W., elected Member, 1877, 163.

FORBES, W. G. L. S., elected Member, 1882, 15.

FORGING OF CRANK SHAFTS, *Paper* on the Forging of Crank Shafts, by W. L. E. McLean, 1879, 461.—First method, by forgerman "finishing the piece before him," 461.—Second method, by "turning the shaft end for end," 464.—Third method, building up the crank by "scarfings" from both sides equally, 465.—Material for crank shafts, 467.—History of scrap iron forgings, 468.—"Rolled scrap bar" as made for crank shafts at Lancefield, 469.—Steel for crank shafts, 470.—Built-up shafts, 470.—"Great Eastern" crank shaft forged at Lancefield, 471.

*Discussion.*—Williams, E., Slabs should not be shorter than the body, 471.—Jamieson, J. L. K., Much larger forgings required in the future, 472; shafts must be built up, 472.—Whitley, J., Crank shafts will be made out of cast steel under pressure, 473.—Reynolds, E., Proper arrangement of piles for effective forging, 473; steel for crank shafts, 474; locomotive crank-shafts of ingot-steel, 475.—Ratliffe, G., At Mersey Works slabs are all drawn to finished length, 475; good puddled iron preferable to present scrap-iron for shafts, 476; definition of steel, 476; mild steel ingots, rolled, cut, and piled, make excellent crank-shafts, 477.—Peacock, R., Locomotive crank-shafts best from good selected scrap, 477.—McDonnell, A., Experience with cast-steel locomotive crank-axles, 477; ditto with Bessemer steel ditto, 478.—Fox, S., Fibrous structure important in forgings, 479.—Howden, J., Quality of forged crank-shafts depends largely upon manner of building up, 479; value of rolled scrap iron, 479.—McLean, W. L. E., Question between iron and steel for crank shafts is one of cost, 479; rolled scrap-iron gives uniform material, 480; slabs drawn to finished length would give much waste, 480; his object to improve the material generally specified, 480; behaviour of steel crank-shafts at sea, 481; built-up shafts heavier and more expensive than solid, 481.—Robinson, J., Welding by friction, 481; different qualities of scrap iron, 482; comparison between cast-steel and scrap-iron, 482; material should be homogeneous, 483.

FORGING, Principles of, 1878, 306.—Heat developed in forging, 1878, 311, 333, 344.

FORREST, W. J., decease, 1874, 2.—Memoir, 19.

FORSYTH, R. A., elected Member, 1882, 254.

FOSTER, J. S., elected Member, 1884, 408.

FOSTER, S. L., decease, 1880, 10.—Memoir, 3.

FOTHERGILL, J. R., elected Member, 1882, 15.

Boiler Corrosion, Marine, 1884, 337.

FOULIS, W., elected Member, 1877, 165.

Water Pressure Regulators, 1879, 442.

FOULIS WATER PRESSURE REGULATORS, 1879, 423. *See* Water Pressure.

FOULKES' CONTINUOUS AUTOMATIC RAILWAY BRAKE, shown at Cardiff meeting, 1884, 357.

FOUNDRY, visited at Glasgow meeting; Walter Macfarlane and Co., 1879, 569.

FOURACRES VERTICAL-ACTION STEAM DREDGER in India, 1879, 534. *See* Dredger.

FOX, F. G. B., elected Member, 1884, 1.

FOX, S., elected Member, 1875, 35.

Forging of Crank Shafts, 1879, 478.

Iron and Steel for Boilers, 1879, 315.

Marine Engine, 1881, 493.

FOX, W., elected Member, 1882, 475.

FRAMPTON, E., elected Member, 1884, 198.

FRANCIS, A. A., elected Graduate, 1880, 186.

FRANCKE "TINA" or Vat Process for Amalgamation of Silver Ores, 1884, 257.  
*See* Silver Ore Amalgamation.

FRANCO, L., Locomotives, Fireless, *Paper* on Fireless Locomotives for Tramways, 1879, 610.—*Reply* to Discussion, 1880, 37.

FRASER, J., decease, 1882, 17.—Memoir, 6.

FRASER, J. H., elected Member, 1877, 71.

FRECHEVILLE, R. J., Silver Ore Amalgamation, 1884, 265.

FRICTION AT HIGH VELOCITIES, Enquiry by W. W. Hulse as to progress of research, 1882, 149.—Westmacott, P. G. B., Arrangements for carrying out experiments, 1882, 150.

FRICTION AT HIGH VELOCITIES, *First Report* to the Council of the Committee on Friction at High Velocities, A. B. W. Kennedy, reporter, 1883, 660.—Influence of velocity upon friction, 660.—Experiments by Jenkin, 660; by Kimball, 661; by Thurston, 662; by Poirée and Bochet, 662; by Galton and Westinghouse, 663.—Letters from G. Cope Pearce and Gen. Morin, 664.—Conclusions from experiments, 664.—*Appendix*, Gen. Morin's letter, 666.

FRICTION BRAKES. *See* Dynamometers, 1876, 199.

FRICTION EXPERIMENTS, *First Report* on Friction Experiments, by B. Tower, 1883, 632.—Description of machine, 632.—Method of experimenting, 634.—Results of experiments, 637.—Pressure between bearing surfaces, 638.—Modes of lubrication, 638.—Oil bath and pad, 640.—Coefficient of

## FRICTION EXPERIMENTS (continued).

friction, 641.—Speed of minimum friction, 642.—Tables I–XI, details of experiments, 643–652.

*Discussion.*—Anderson, W., Lubrication from beneath, 653.—Wicksteed, J. H., Slower speed allows higher pressure without seizing, 653.—Robinson, J., Practicable application of oil-bath, 654.—Davey, H., High pressures possible on bearings at slow speeds, 654.—Paget, A., Journal friction approximates more to liquid friction than to solid, 654; friction must be intermittent for high pressures, 655; “dithering” friction, 655.—Lea, H., Difficulty of working lathe with loose bearing, 655.—Smith, R. H., Overhanging journals get unequal pressure, 655; oil-bath applied from above, 656; results obtained by Prof. Thurston, 656; coefficient of friction diminishes with increase of pressure, 656; variation of friction with temperature, 656; testing apparatus at Mason Science College, 657.—Halpin, D., Constant and intermittent friction on bearings in locomotives, 657.—Cowper, E. A., Lubrication of bearings in marine engines, 657.—Williams, R. P., Axle-friction of railway vehicles, 658; grooving of axle-brasses, 658.—Westmacott, P. G. B., Adjournment of discussion, 659.

*Adjourned Discussion.*—Tower, B., Alternation in direction and short duration of high pressure in punching and shearing machines, 1884, 29; value of profuse lubrication, and great consequent diminution of friction, 29; profuse lubrication is possible without waste, 29; trial-trip lubrication should be kept up at all times, 30; high pressure on crank-pins is alleviated at high speeds by inertia of reciprocating parts, 30; probable springing of cap of lathe-mandril, 31; experimental journal was not overhanging, 31; dashpot was unnecessary for steadying pointer, 31; coefficient of friction remains very steady with oil-bath lubrication, 31; temperature maintained constant in these experiments, 32; explanation of loads stated in the tables, 32; method of grooving the experimental brasses, 33.—Fell, J. C., Load upon experimental bearing was on same face on which the lubrication was applied, 33; in many ordinary bearings it is on opposite face, 33; end-play of bearings may affect lubrication, 33; diagrammatic representation of results, 34.—Rich, W. E., High-speed bearings lubricated from beneath in wood-working machinery, 34.—Tower, B., Experimental bearing must be of typical form, 34; practical effect of end-play in brasses, 34; middle of seat of pressure is worst place for introducing lubricant, 35.

FRICTION, static and dynamic, 1878, 599. *See* Brakes.

FRISBIE MECHANICAL FIRE-FEEDER, 1876, 318. *See* Fire-Feeder, Mechanical.

FROMENTIN AUTOMATIC BOILER FEEDER, 1882, 479. *See* Boiler Feeder.

FROSSARD, C. E., elected Graduate, 1879, 38.

FROST, W., elected Member, 1876, 28.



FROUDE, W., decease, 1880, 10.—Memoir, 3.

Dynamometer, Marine-Engine, *Paper* on a new Dynamometer for measuring the power delivered to the Screws of large ships, 1877, 237.

—*Appendix*, 252.—Remarks, 261, 268.

Expansion, Variable Automatic, 1877, 283.

Rock-Drilling Machinery, 1877, 217.

FROUDE'S GOVERNOR, 1884, 192, 195.

FUEL CONSUMPTION IN LOCOMOTIVES, 1884, 82. *See* Locomotives.

FUEL, Petroleum Refuse as Fuel in Locomotive Engines, 1884, 272. *See* Petroleum Fuel in Locomotives.

FUNG YEE, elected Associate, 1883, 180.

FURNACES. *See* Blast-Furnace Capacity, 1875, 334.—Blast-Furnace Working, 1882, 279.—1883, 93.

FURNESS, E., elected Member, 1884, 79.

FURNESS HÆMATITE IRON MINES, 1880, 363, 484, 485, 487. *See* Mines.

FURRELL, E. W., elected Member, 1882, 475.

## G.

GALLAND, A., Ghent, Description of Works &c. visited, 1883, 564.

GALTON, D., Armour, Construction of, 1879, 74.

Brakes, *First Paper* on the Effect of Brakes upon railway trains, 1878, 467.

—Remarks, 479, 488.

*Second Paper* on ditto, 1878, 590.—Remarks, 616, 630.

*Third Paper* on ditto, 1879, 170.—Remarks, 194, 215.

Bridge, Erection of, over river Dal, 1876, 54.

Railway Working, Economy of, 1879, 144, 151.

GALWEY, J. W. DE V., elected Member, 1880, 9.

GANGA RAM, Lala, elected Member, 1884, 408.

GARDENS, NURSERY, L. van Houtte's, visited at Summer meeting, Belgium, 1883, 517, 567.

GARRETT, F., elected Member, 1882, 254.

GARRETT, R., elected Member, 1882, 254.—Memoir, 1884, 400.

GAS-ENGINE, ATMOSPHERIC, *Paper* on Otto and Langen's Atmospheric Gas Engine, and some other gas engines, by Francis W. Crossley, 1875, 191.—Principle of Otto and Langen's engine, the "free piston," 191.—Other type of gas engines acting by pressure of explosion, 191.—Objections to driving by direct pressure, 192.—Description of atmospheric gas engine, 194.—Reciprocating friction clutch, 195.—Slide-valve for admitting and exploding the gas, 196.—Governor regulating the interval between each stroke, 197.—Improved governor giving complete control, 197.—

## GAS-ENGINE, ATMOSPHERIC (continued).

Comparison with steam engine, 198.—Greater power of gas than of steam per heat unit, 199.—Indicator figures from gas engines, 200.

*Discussion.*—Cowper, E. A., Leakage of piston caused by deposit in cylinder, 201; direct pressure of explosion not so applicable for driving as vacuum principle, 202.—Paget, A., Atmospheric principle good for utilising full power of explosion, 203; wear of leather, and back-lash in driving clutch, 204; friction drum for obviating noise, 204.—Reynolds, E., Ready means of starting, 205; small cost of working, 205; noise made in working chiefly caused by clutch, 205.—Maw, W. H., Experiments with different proportions of gas and air, 205.—Head, J., Action of products of explosion upon metal of cylinder, 206; accumulation of tar in cylinder, 206.—Cowper, E. A., Consumption of fuel compared with steam, 207.—Carbutt, E. H., Gas much less expensive than steam for intermittent work, 207.—Ramsbottom, J., Heat developed by explosions cannot be serious, 208.—Deacon, G. F., Gas engines found more economical for intermittent work than small steam engines, 208.—Smith, W. Ford, Effective pressure on piston, 209.—Ramsbottom, J., Effective pressure, 209.—Cowper, E. A., Trials of explosive mixtures of gas and air, 210.—Tweddell, R. H., Gas engine ought to be compared with engines working intermittently, 210.—Simon, H., Number in use, 211.—Cochrane, C., Effect of gases on metal of cylinder, 211.—Crossley, F. W., Small wear of cylinder, 211; efficiency of mode of governing, 211; means of keeping cylinder clean, 212; limit to size of engines, 212; theoretical efficiency of engine, 212; durability of friction clutch, 213; comparative cost of working gas engine and small steam engine, 213; wear of cylinder, 214; separate combustion chamber not advisable, 215.—Bramwell, F. J., Advantage over other gas engines, 215; gas much cheaper than water for working engines of small power, 216; explosive mixtures of various proportions, 216; advantage of free piston for utilising force of explosion, 216.

GAS EXHAUSTER, Greindl rotary, 1878, 462.

GASHOLDERS at Manchester Gas Works, 1881, 626.

GASES OCCLUDED, in copper, 1880, 412.—In palladium, 232, 410.—In platinum, 415.—In silver, 410.—In steel, 155, 158, 228, 232, 402, 404, 409, 410, 414.  
*See Steel.*

GAS WORKS, Paris, visit to, 1878, 547.—Cardiff, 1884, 366.

GAUGE, *Paper* on a Standard Gauge for High Pressures, by G. Marié, 1880, 455.—Increasing use of higher pressures, 455.—Metallic gauges, difficulties of graduation, 455.—Open-tube manometer, 455.—Standard gauges with compressed-air, with differential pistons, and with loaded valves, 456.—New system of piston-gauge, 457.—Leakage, friction, and lubrication,

## GAUGE (continued).

458.—General arrangement, 459.—Objections to new gauge, and calculation of errors, 459.—Elimination of friction from dirt, 460.—Friction of metallic gauges, 461.—Frictionless spiral gauge, 461.—Accuracy of new standard gauge, 462.—Applications of new system, 462.—Appendix, estimate of errors, 464-468.—Summary of errors, 468.—Application to actual apparatus, 469.

*Discussion.*—Allan, A., Description of air-spring pressure-gauge, 470; inaccuracy of ordinary pressure-gauges, 471.—Ross, J. A. G., Earlier gauge of same kind, and difficulty from grit, 472; what provision for change of temperature in air-spring gauge, 472.—Allan, A., No serious development of heat, 472; means of replenishing air in gauge, 472.—Ross, J. A. G., Absorption of air by water in air-spring gauge, 472.—Allan, A., No absorption in practice, 472.—Maw, W. H., Gooch's combined pressure-gauge and safety-valve, 473.—Cowper, E. A., Gauging of indicators, 473.—Lüthy, R., Hick's experiments on friction of leathers, 473; Whitworth's piston-gauge, and Fogg's mercurial gauge, 473; apparatus for measuring friction of leather collars, 473.—Humphrys, J., Difficulty from dirt to be obviated by using oil, 474.—Ellington, E. B., Similar gauge for chain-cable testing, but not superseding dead weights, 474.—Tweddell, R. H., Value of theoretical investigation in confirming practice, 474; accumulator best pressure-gauge for hydraulic machinery, 474; pressure-gauge with two independent pointers, 475; indicator diagrams at high pressures, 475.—Marié, G., Air-spring for low pressures only, 475; dirt obviated by filtering water, 475; principle of standard gauge is that of Watt's indicator, 475; new method for measuring friction, 475; friction in pistons packed with diaphragms, 476; standard gauge not for daily use, 476; recent test of accuracy with open-tube gauge, 476.

GAUGE, RAILWAY, *Paper*, Notes on the early history of Railway Gauge, by W. Pole, 1875, 66.—Origin of railway gauge, flange wheels on tramways, 67.—Stockton and Darlington gauge adhered to on other railways, 68.—Body of first railway vehicles within the wheels, 69.—Width increased by bodies overhanging the wheels, 70.—Origin of the 6 ft. space between up and down lines, 71.—Reasons for adopting 7 ft. gauge, 73.—Points of gauge controversy, 74.—Superiority of broad gauge, 74.—Evil of the break of gauge, 74.—Importance of returning to the loose wheel for curves, 75.—Objection to further narrowing of the gauge, 75.

*Discussion.*—Bramwell, F. J., Mechanical objection to vehicles overhanging the wheel-base, 77.—Cowper, E. A., Narrow gauge more convenient and cheaper working than broad, 77; early plans proposed on broad gauge not found to answer, 78; narrow-gauge engines attain as high a speed as broad, 79; broad gauge being finally abandoned, 80.—

## GAUGE, RAILWAY (continued).

Armstrong, Joseph, Variation in early gauges, 80; construction of early vehicles on Liverpool and Manchester line, 81; working of broad gauge not more expensive than of narrow on Great Western, 81; designs of early large locomotives for broad gauge, 82.—Webb, F. W., Alteration of gauge on Wylam line, 82½; distance between up and down lines, 83.—Coode, Sir J., Origin of gauge on Liverpool and Manchester line, 83; early large locomotives, 84; Great Western Railway, original permanent way, 84.—Armstrong, Joseph, Alteration of gauge on Stockton and Darlington, 84.—Barry, J. W., Cost of working broad gauge less than that of narrow, 84: loose wheels upon railway axles very desirable, 85.—Robinson, John, Great variety of gauge in other countries, 85; narrow gauge originally adopted accidentally, 86; loose wheels very desirable, 87.—Poole, W., Origin of present type of railway vehicle, 88; Brunel's object in widening the gauge, 88; loose wheels, point of superiority in road type of vehicle, 88.—Bramwell, F. J., Particulars of various gauges, 89; consideration of mechanical objection to vehicles overhanging the wheel base, 89; advantage of loose wheels, 90.

GAUGE, RAILWAY, *Supplement* to Notes on the early history of Railway Gauge, respecting the origin of the 4 ft. 8½ inch gauge, communicated by W. P. Marshall, Secretary, 1877, 158.—Original railway gauge was 4 ft. 8 in. instead of 4 ft. 8½ in., 158.—Stockton and Darlington railway originally 4 ft. 8 in. gauge, 158.—Alteration of gauge carried out gradually, 159.—Early colliery lines also 4 ft. 8 in. gauge, 160.—Liverpool and Manchester railway commenced with 4 ft. 8 in. gauge, 160.—Conical tyres first used on Liverpool and Manchester railway, requiring increased play between rails, 161.—Addition of half inch for this purpose, making 4 ft. 8½ in. gauge, 161.—Several succeeding railways originally 4 ft. 9 in. gauge, 161.—Newcastle and Carlisle railway 4 ft. 8 in. gauge on first portion, 162.

GEACH, J. J., elected Member, 1878, 107.—Memoir, 1884, 401.

Rock-Drilling Machinery, *Paper* on the Mechanical Appliances used in the construction of the heading under the Severn for the Severn Tunnel Railway, 1877, 206.—Remarks, 216. 217. 218.

Tynewydd Colliery Inundation, 1877, 228.

GEARING, ROPE, 1876, 372. *See* Rope Gearing.

GEOGHEGAN, S., elected Member, 1880, 310.

GEORDIE SAFETY LAMP, 1879, 221. *See* Safety Lamps.

GHENT, Works &c. visited at Summer meeting, Belgium, 1883, 517. Description of Works, by A. Galland, 564.—Cotton Mills, 564.—Flax and Tow Mills, 565.—Cotton Spinning Works, 565.—New Dock Works, 566.—Nursery Gardens, 567.—Engine Works, 568.

GIBBONS, B., decease, 1874, 2.—Memoir, 19.

- GIBBONS, C. K., elected Graduate, 1883, 594.
- GILCHRIST, P. C., elected Member, 1883, 309.
- GILL, C., elected Member, 1880, 310.
- GILLET, J., elected Member, 1876, 57.
- GIMSON, A. J., elected Member, 1884, 79.
- GIMSON, J., elected Member, 1878, 293.—Decease, 1884, 3.—Memoir, 63.  
Hydraulic Machinery, Toulon, 1878, 387.
- GIRDLESTONE, J. W., elected Member, 1884, 79.
- GIRDWOOD, W. W., elected Member, 1881, 163.
- GJERS, J., elected Member, 1874, 101.
- GLAMORGAN COAL CO.'s Llwynypia Colliery, Rhondda Valley, 1874, 234.
- GLASGOW MEETING, Invitation, 1879, 51, 218.—Meeting, 395.—Reception, 395.  
—Votes of thanks, 563.—Works visited and Excursions, 567.—Dinner, 576.
- GLASS, TOUGHENED, De la Bastie's, 1879, 226, 236.
- GLASS WORKS, Val St. Lambert, visited at Belgian meeting. 1883, 513, 544.
- GODFREY, W. B., elected Member, 1880, 185.
- GOLDSMITH, A. J., elected Member, 1882, 145.
- GOLDSWORTHY, R. B., elected Member, 1879, 583.
- GOOD, H., elected Member, 1884, 408.
- GOODBODY, R., elected Member, 1877, 165.
- GOODFELLOW, G. B., elected Member, 1875, 314.
- GOODGER, W. W., elected Member, 1884, 80.
- GORDON, R., elected Member, 1875, 65.  
South-Wales Mineral Wagons, 1884, 432.  
Testing Current-Meters, *Paper* on the Apparatus used for Testing Current-Meters, at the Admiralty Works at Torquay for experimenting on models of ships, 1884, 190.—Remarks, 195.
- GORMAN, W. A., elected Member, 1879, 155.  
Cold Air, Machines for producing, 1881, 127.  
Diving Appliances, *Paper* on Appliances for Working under Water or in Irrespirable Gases, 1882, 179.—Remarks, 189, 193, 194, 201.  
Raising of wreck "Edith," 1878, 130.
- GOTTSCHALK, A., elected Member, 1880, 310.  
Locomotives, Compound, 1883, 449.
- GOULTY, W. R., elected Member, 1877, 165.
- GOVERNOR, Froude's, 1884, 192, 195. *See* Testing Current-Meters. Knowles Supplementary Governor, 1884, 157. *See* Engine Recorder.
- GOVERNOR, MARINE, *Paper* on the Pneumatic Marine Governor, by D. J. Dunlop, 1879, 406.—Importance of governor for screw steamers, 406.—Governors worked by acceleration not sufficient for compound engines, 407.—Description of pneumatic marine governor, 407.—Application, 408.



## GOVERNOR, MARINE (continued).

*Paper on the "Velometer" governor for marine and stationary engines, by F. W. Durham, 1879, 410.—Ordinary governors not sensitive enough for compound marine engines, 410.—Description of "Velometer" governor, 410.—Action of ditto, 411.—Arrangement for working ditto by pitching of ship, 412.—Equilibrium-valve arrangement for large compound engines, 412.—Marine governor should be kept always at work, 413.—Arrangement of governor for stationary engines, 413.*

*Discussion.—Wilson, R., Principle of pneumatic governor correct, 415.—Boyd, W., Danger of equilibrium-valve as proposed for velometer, 415.—Cowper, E. A., Is not pneumatic governor rather slow in action, 415; Jensen's marine governor, 416; no practical danger from equilibrium-valve with velometer governor, 416; bevel gearing same as in White's dynamometer, 416.—Unwin, W. C., Small air-pump might be better than large air-vessel of pneumatic governor, 417.—Gray, J. M., Earlier designs of marine governors somewhat similar, 417.—Hill, L., Hydraulic governor for retarding railway trains, 418; governing marine engines by pitching of ship originally applied by Mr. Waddell, 418.—Dunlop, D. J., Action of pneumatic governor very rapid, 419; size of air-vessel and air-pipe, 419; largest size of governor, 419; delicacy of action, 419; use of air-pump instead of air-vessel not practicable, 420; extent of application, 420; disadvantage attending previous applications of the principle, 420; water communication not quick enough in action, 421.—Durham, F. W., Equilibrium-valve produces no sudden check, 421; extent of application of velometer, 421.—Robinson, J., Utility of both forms of governor, 421.*

GOVERNOR for Water Pressure, Foulis', 1879, 423.—Barten and Wests', 434.

*See Water Pressure.*

GOVERNORS regulating Expansion, 1882, 408. *See Expansion Gear.*

GOWAN's permanent way for Tramways, 1880, 197. *See Tramways.*

GOWENLOCK, A. H., decease, 1883, 36.—Memoir, 18.

GRAFTON, A., elected Member, 1878, 31.

GRAINGER, J. N., decease, 1882, 17.—Memoir, 8.

GRAMME DYNAMO-ELECTRIC MACHINE, 1878, 520, 540.—1880, 267, 269, 274-6, 283, 284. *See Electric Lighting.*

GRAVING DOCKS, 1884, 233. *See Docks.*

GRAY, J. McF., Cold-Air, Machines for producing, 1881, 128.

Governors, 1879, 417.

Harvesting Machinery, 1881, 52.

Locomotives, Compound, 1879, 362, 388.

Power Transmission by Ropes, 1874, 71.

Raising of Wreck "Edith," 1878, 133.

Secretary, appointment, 1884, 78.

GRAY, J. McF. (continued).

Water Pressure Regulators, 1879, 437.

GRAY, J. W., elected Member, 1876, 197.

GRAY, T. L., elected Member, 1879, 583.

GREATHEAD, J. H., elected Member, 1879, 155.

Injector Hydrants, *Paper* on Injector Hydrants for fire extinction, 1879, 364.—Remarks, 391.

GREAT WESTERN COLLIERY visited at Summer meeting, Cardiff, 1884, 357, 369.

GREAT WESTERN LOCOMOTIVE AND CARRIAGE WORKS at Swindon, 1877, 298.

GREAT WESTERN RAILWAY, original proposal of construction, 1875, 78, 84.

GREAVES, J. H., decease, 1880, 10.—Memoir, 5.

GREENHILL, A. G., Shafting, *Paper* on the Strength of Shafting when exposed both to Torsion and to End Thrust, 1883, 182.—Remarks, 210, 224.

GREENWOOD, A., elected Member, 1878, 293.

Wool-Combing Machinery, 1882, 227.

GREENWOOD, J., elected Associate, 1875, 190.

GREENWOOD, T., decease, 1874, 2.—Memoir, 20.

GREENWOOD, W. H., elected Member, 1874, 55.

GREIG, A., elected Graduate, 1878, 294.

GREIG, D., elected Member of Council, 1878, 29.—1881, 30.—1884, 21.

Feed-Water Heater and Filter, 1881, 546.

Hydraulic Machinery, Toulon, 1878, 383.

Hydraulic Machinery, Workshop, 1874, 189.

Iron and Steel for Boilers, *Paper* on experiments referring to the use of Iron and Steel in high-pressure Boilers, 1879, 268.—Remarks, 303, 322, 324.

Mining Machinery, 1882, 365.

Steam-ship "City of Rome," 1880, 354.

Testing Machine, Single-Lever, 1882, 393.

Tramways, Mechanical Traction, 1878, 427, 433.

GREINDL ROTARY PUMP, 1878, 440. *See* Pump, Greindl Rotary.

GRESHAM, J., elected Member, 1880, 310.

Injector, Automatic, 1884, 180.

GREW, F., elected Member, 1883, 179.

GREW, N., elected Member, 1874, 55.

GRICE, F. G., decease, 1882, 17.—Memoir, 8.

GRIFFITHS, J. E., elected Member, 1884, 80.

GRIFFITHS, J. R., elected Member, 1874, 101.

GROSE, A., elected Member, 1879, 155.

GROSVENOR, Rt. Hon. Lord R., elected Associate, 1878, 293.

GRUNDY, R., elected Member, 1877, 165.

GRUNDY, R. D., elected Member, 1876, 347.—Decease, 1880, 10.—Memoir, 5.

GUINOTTE, L., elected Member, 1883, 593.

Collieries, Maricmont and Bascoup, 1883, 570.

GULLAND, J. K., elected Member, 1884, 198.

GUNS. *See* Steel, Fluid Compressed, and Guns, 1875, 268.

GURDEN, C. F., decease, 1875, 3.—Memoir, 25.

GUTCH, G. A., Brakes, Automatic Action, 1880, 117-128.

## H.

HADFIELD, R., elected Member, 1879, 155.

HÆMATITE IRON MINES, Furness, 1880, 363, 484, 485, 487. *See* Mines.

HAERLEM LAKE, compound Cornish pumping engine, 1874, 265.

HAGGARD, F. T., Brakes, Effect of, upon railway trains, 1878, 622.

HAGGIE, D. H., elected Associate, 1880, 310.

HAILSTONE QUARRY, Basalt, 1876, 336.

HALL, A. F., elected Member, 1884, 1.

HALL, J., decease, 1877, 2.

HALL, J. F., elected Member, 1879, 583.

HALL, J. P., elected Member, 1881, 163.

HALL, J. W., elected Member, 1882, 254.

HALL, T. B., elected Member, 1874, 55.

Boiler, Lancashire, 1876, 119.

HALL, W. S., Boiler, Lancashire, 1876, 109.

Brakes, Effect of, upon railway trains, 1878, 624.

Drilling Machines, *Paper* on Drilling Machines used for boiler work, 1878, 565.—Remarks, 577, 588.

Engines, Winding, Direct-Acting, 1875, 238.

Iron and Steel for Boilers, 1879, 316.

Mining Machinery, 1882, 375.

Riveted Joints, 1881, 269.

Steam-ship "City of Rome," 1880, 348.

Steel, Chernoff's papers, 1880, 233.

Ventilators for Mines, Mechanical, 1875, 328.

Watt, Inventions of James Watt, 1883, 629.

HALL'S PORTABLE BOILER-SHELL DRILLING MACHINE, 1878, 572, 575, 576, 577, 588.

HALLETT, J. H., elected Member, 1880, 489.

Boiler Corrosion, *Paper* on the Causes and Remedies of Corrosion in Marine Boilers, 1884, 331.—Remarks, 347.

HALPIN, D., Boiler Feeder, Fromentin Automatic, 1882, 495.

Diving Appliances, 1882, 192, 194.

## HALPIN, D. (continued).

- Dock, Victoria Floating, 1878, 177, 181, 182.
- Expansion Gear, Automatic, 1882, 434.
- Friction Experiments, 1883, 657.
- Hydraulic Machinery, Marine, 1874, 43.
- Injector, Automatic, 1884, 180.
- Locomotive, Brown's Tramway, 1880, 69.
- Locomotives, Compound, 1883, 455.
- Locomotives, Fuel Consumption, 1884, 103, 110.
- Petroleum Fuel in Locomotives, 1884, 316.
- Raising of wreck "Edith," 1878, 129, 137.
- Riveted Joints, 1881, 273.
- Testing Machine, Single-Lever, 1882, 401.

HAMBLING, T. C., decease, 1874, 2.—Mémorial, 21.

HAMILTON, Bailie, Dredging in Clyde, 1879, 564.

Vote of thanks, Reply to, 1879, 563.

HAMMERS, *Paper* on Power Hammers with a Movable Fulcrum, by D. Longworth, 1882, 204.—Previous plans for altering force of blow, 204.—Small planishing hammer, 205.—Medium-size forging hammer, 207.—Foot and hand labour for forging and stamping, 209.

*Discussion.*—Bamlett, A. C., Successful working of hammer, 210.—Joy, D., Effect of jar on lever of hammer, 210; superior durability of ash-wood, 210.—Smyth, J. J., Relative economy of steam-hammers and power-hammers, 211.—Paget, A., Wear of belt from slipping with heavy blows, 211.—Lloyd, S. Z., Whether hammer used for bolts or rivets, 212.—Longworth, D., Pneumatic connection prevents jar, 212; absence of piston-rings, and freedom from wear and tear, 212; slip of driving belt only occasional, 212; hammers not used for bolts or rivets, but for forging in dies, drawing down, planishing, &c., 213.

HAMMOND, W. J., elected Member, 1875, 65.

HANDYSIDE, J. B., elected Member, 1879, 155.—Decease, 1883, 36.—Mémorial, 18.

HANNAY'S ELECTROGEN, 1884, 335, 342, 348, 356. See Boiler Corrosion.

HARBOUR WORKS, *Paper* on the new Harbour Works at Antwerp, by G. A.

Royers, 1883, 494.—Situation and history of port, 494.—New works in progress, 497.—First section of works, new basins for small craft, 498.—Lock between basins and river, 499.—Embankment, 500.—New quays, 501.—Quay wall, 502.—Caissons for foundation of wall, 503.—Movable cofferdam, and floating framework, 504.—Method of working, 505.—Discharge of spoil, 506.—Joggling of lengths of wall, 507.—Railways on quays, 507.—Hydraulic machinery on quays, 508.—New dry docks, 508.—Tunnel for emptying ditto, 509.—Hydraulic machinery for northern docks, 509.—Further dock extensions, 510.

- HARBOUR WORKS, visited at Glasgow meeting ; Greenock, 1879, 579.
- HARDCASTLE, R. A., elected Associate, 1874, 256.
- HARDING, W. B., elected Member, 1874, 101.
- HARDINGHAM, G. G. M., elected Member, 1881, 163.
- HARDY, J. G., elected Member, 1883, 33.
- HARKER, H. H., elected Member, 1884, 198.
- HARMAN, H. W., decease, 1876, 3.—Memoir, 20.
- HARRIS, H. G., elected Member, 1879, 155.
- HARRIS, W. W., elected Member, 1877, 71.
- HARRIS' NAVIGATION COAL CO.'S COLLIERY, near Quaker's Yard, diamond rock-drilling machine, 1874, 249.
- HARRISON, G., elected Member, 1879, 398.—Decease, 1876, 3.—Memoir, 21.
- HARRISON, W. A., memoir, 1884, 402.
- HARRISON, G., decease, 1876, 3.—Memoir, 21.
- HART, JAMES (London), elected Member, 1874, 101.
- HART, JAMES (Manchester), elected Member, 1877, 26.
- HART, F., elected Member, 1883, 309.
- HART, N., elected Graduate, 1882, 16.
- HARTLEY, J. W., Portable Railways, 1884, 141.
- HARTNELL, W., Dynamometer, Marine-Engine, 1877, 267.
- Expansion Gear, Automatic, *Paper on Governing Engines by Regulating the Expansion*, 1882, 408.—Remarks, 431, 436, 437, 439.
- Expansion, Variable Automatic, 1877, 284, 288.
- Valves, Safety, 1877, 187.
- HARVESTING MACHINERY, *Paper on Harvesting Machinery*, by E. Samuelson, 1881, 34.—Classification of harvesting machinery, 34.—Mowing machines, 35.—Cutting apparatus, 35.—Parallel lift of cutter bar, 38.—Balance arrangement for draught, 39.—General features of design, 39.—Speed and throw of knife, 40.—REAPING machines, 40.—Manual back-delivery reaper, 41.—Combined mower and manual reaper, 41.—Automatic back-delivery reaper, 42.—Side-delivery reapers, 43.—Combined mower and side-delivery reaper, 45.—Automatic sheaf-binders, 45.—Different forms of wire-binding mechanism, 47.—Ditto of string-binding mechanism, 49.—Difficulties in automatic binders, 51.
- Discussion*.—Samuelson, E., Models of machines &c., 52.—Cowper, E. A., Diagrams are a sample, 52.—Gray, J. McF., Colouring of diagrams, 52.—Adamson, D., Tractive power for different crops &c., 52; what becomes of wire, and how are wire-bound sheaves undone, 53.—Rich, W. E., Draught and other statistics for reaping machines, 53.—Bale, M. P., Circular saw for cutting fingers, 54; cutting of crops high above ground, 54.—Paget, A., Unexplored ground in this subject, 54.—Samuelson, E., Pliers for undoing wire-bound sheaves, 54; string-binders preferable, 55; machines cutting high above ground, 55; saw for slotting fingers, 55.



- HARVEY, C. R., elected Member, 1882, 475.  
 HARVEY, R., elected Member, 1883, 33.  
 HARWOOD, R., elected Member, 1878, 558.  
 HASARD COLLIERIES, visited at Summer meeting, Belgium, 1883, 515, 531.  
 HASKINS, J. F., elected Member, 1882, 145.  
     Brakes, Effect of, upon railway trains, 1879, 207.  
 HASLAM, A. S., elected Member, 1881, 9.  
 HASLUCK, P. N., elected Associate, 1884, 199.  
 HASTIE, J., Water-Power Engines, *Paper* on Water-Power Engines with variable stroke, 1879, 484.—Remarks, 491.—Hoist shown in operation, 577.  
 HASWELL, J. A., Brakes, Effect of, upon railway trains, 1878, 482.  
     Locomotive Running Shed, 1884, 249.  
 HAUGHTON, T., elected Member, 1878, 293.  
 HAULAGE, UNDERGROUND, by Compressed Air. *See* Compressed-Air Machinery, 1874, 204.  
 HAULING ENGINES, Fixed and Portable, 1874, 207.  
 HAULING ENGINES, Hydraulic, 1874, 130.  
 HAUZEUR-GÉRARD, Spinning Works for Carded Wool, visited at Summer meeting, Belgium, 1883, 515.—Note on Works, 550.  
 HAWKINS, C. W., decease, 1876, 3.—Memoir, 22.  
 HAWKSLEY, C., Accidents, Mine, *Paper* on Special Mechanical Appliances for meeting the requirements of certain classes of Mine Accidents, by C. Hawksley and E. B. Marten, 1877, 314.—Remarks, 324, 343.  
     Bath, Floating Swimming, 1875, 154.  
     Boiler and Engine, High-Pressure, 1877, 147.  
     Brakes, Continuous, for railway trains, 1878, 93. †  
     Brakes, Effect of, upon railway trains, 1878, 486.—1879, 213.  
     Diving Appliances, 1882, 192, 195.  
     Dredger, Bazin, 1882, 116.  
     Dynamometer, Marine-Engine, 1877, 265.  
     Expansion Gear, Correy, 1878, 523.  
     Pump, Greindl Rotary, 1878, 464.  
     Tynewydd Colliery Inundation, 1877, 230.  
     Water Meters, 1882, 89.  
     Water-Pressure Mining Engines, 1880, 257.  
     Water Supply from Chalk, 1876, 172.  
 HAWESLEY, T., elected Vice-President, 1874, 26.—1875, 34.—President, 1876, 26, 27.—1877, 25.  
     Accidents, Mine, Mechanical Appliances for, 1877, 347.  
     Address, Presidential, 1877, 167.  
     Axlebox, Radial, 1877, 313.  
     Bath, Floating Swimming, 1875, 154.  
     Blast-Furnace Capacity, 1876, 44.

## HAWKSLEY, T. (continued).

- Boiler, Lancashire, 1876, 125.
- Boiler and Engine, High-Pressure, 1877, 124, 142, 150, 155.
- Bridge, Erection of, over the river Dal, 1876, 54, 55.
- Condenser, McCarter, 1876, 310, 311, 317.
- Dynamometers, 1876, 241, 243.
- Dynamometer, Marine-Engine, 1877, 263, 268.
- Filter, Farquhar, 1881, 155, 157, 158, 159, 161.
- Fire-Feeder, Frisbie Mechanical, 1876, 321, 327.
- Iron, Homogeneous, 1877, 91.
- Power Transmission by Ropes, 1874, 75.
- President, on retiring from office, 1878, 32.
- Pressure-Intensifying Apparatus, 1878, 62.
- Puddling, Mechanical, 1876, 295.
- Rock-Drilling Machinery, 1877, 216, 217, 218.
- Rope Gearing, 1876, 382, 397, 400.
- Rules, 1874, 32.—1879, 44, 45.
- Steel Boiler Experiments, 1878, 258, 260.
- Tuyere, Open Spray, 1876, 365, 371.
- Tynwydd Colliery Inundation, 1877, 227, 231, 235.
- Votes of thanks, 1878, 33.—To retiring President, 1884, 24.
- Water Meters, 1882, 70, 79, 82.
- Water Supply from chalk, 1876, 170, 176.

HAWTHORN, T., elected Member, 1880, 9.—Decease, 1881, 11.—Memoir, 4.

HAYES, E., elected Member, 1882, 254.

HAYES, J., elected Member, 1879, 38.

Boiler Feeder, *Paper* on the Fromentin Automatic Boiler Feeder, 1882, 479.—Remarks, 485, 488, 495, 497, 498.

Steel Compression by Steam, 1880, 411.

HAYTER, H., elected Member, 1880, 185.

Raising of wreck "Edith," 1878, 132.

HEAD, JEREMIAH, elected Member of Council, 1874, 26.—1876, 26.—1879, 36.—

Vice-President, 1880, 24.—1883, 53.

Accidents, Mine, Mechanical Appliances for, 1877, 339.

Boiler Feeder, Fromentin Automatic, 1882, 491.

Boiler, Lancashire, 1876, 104, 108, 115.

Boiler and Engine, High-Pressure, 1877, 130.

Boilers, Non-conducting covering, 1874, 277.

Brake, Automatic Screw-Brake, 1882, 509.

Bridge, Erection of, over the river Dal, 1876, 53.

Cultivation by Horses, 1880, 550.

Cutting of Metals, 1883, 257.

## HEAD, JEREMIAH (continued).

- Diving Appliances, 1882, 191, 198.
- Docks, Cardiff, 1874, 137.
- Docks, Pumping Machinery, 1874, 158.
- Drilling Machines for Boiler Work, 1878, 582, 583.
- Engines, Pumping, Direct-Acting, 1874, 277.
- Engines, Winding, Direct-Acting, 1875, 233.
- Exhibition, *Report* on the North-East Coast Exhibition of Marine Engineering, &c., 1882, 472.
- Feed-Water Heater and Filter, 1881, 548.
- Gas Engine, Atmospheric, 1875, 206.
- Iron, Homogeneous, 1877, 87.
- Lifts, Hydraulic, 1882, 165.
- Locomotives, Francq's Fireless, for Tramways, 1879, 633.
- Marine Engine, 1881, 495.
- Mining Machinery, 1882, 374.
- Petroleum Fuel in Locomotives, 1884, 311.
- Plate Rolling Machinery, 1880, 91.
- Pressure-Intensifying Apparatus, 1878, 57.
- Puddling, Mechanical, 1876, 266, 281, 284.
- Riveted Joints, 1881, 269, 270, 279.
- Rope Gearing, 1876, 393.
- Rules, 1876, 31.—1877, 38.—1878, 37.—1880, 33.
- Secretary, Vote to late, 1878, 113.
- South-Wales Mineral Wagons, 1884, 435.
- Steel Boiler Experiments, 1878, 246.
- Steel, Chernoff's papers, 1880, 238.
- Steel Plant, Bessemer, 1881, 640.
- Testing Machine, Single-Lever, 1882, 391.
- Thrashing Machines, 1881, 396.
- Traction Engines in India, 1879, 516.
- Tramways, Mechanical Traction, 1878, 431.
- Tramways, Permanent Way, 1880, 214.
- Tuyere, Open Spray, 1876, 367.
- Valve-Gear, Joy's, 1880, 441.
- Ventilators for Mines, Mechanical, 1875, 330.
- Ventilator, Roots' Mine, 1877, 108.
- Vote of thanks to retiring President, 1882, 35.—to President for Address, 1884, 224.
- Water Meter, Barton and West's, 1879, 452.
- Watt, Inventions of James Watt. 1883, 626.
- Wood-Working Machinery, 1875, 264.

- HEAD, JOHN, decease, 1882, 17.—Memoir, 8.
- HEAP, W. E., elected Member, 1878, 31.
- HEATER AND FILTER for Feed-Water, 1881, 539. *See* Feed-Water Heater and Filter.
- HEATH, A. M., elected Graduate, 1882, 16.
- HEATON, A., elected Graduate, 1877, 299.
- HEDGES, K. W., elected Member, 1878, 107.
- Electric Lighting, 1880, 282.
- Electricity for Coal Mining, 1883, 435.
- HEDLEY, H., elected Graduate, 1874, 27.
- HEDLEY, T., elected Graduate, 1874, 27.
- HEENAN, R. H., elected Member, 1875, 189.
- HELICAL PUMP, 1874, 281. *See* Pump, Helical.
- HEMP PACKING for Hydraulic Machines. *See* Packing.
- HENCHMAN, H., elected Member, 1879, 155.
- HENDERSON, J. B., elected Member, 1883, 309.
- HENDERSON, W., elected Graduate, 1883, 34.
- HENESEY, R., elected Member, 1878, 558.
- HENRIQUES, C. Q., elected Graduate, 1879, 584.
- HEPBURN, G., elected Member, 1875, 35.
- HEPPELL, T., elected Member, 1876, 347.
- HEPWORTH, T. H., elected Member, 1877, 72.
- HERNU, A. H., elected Member, 1884, 80.
- HERVEY, M. W., elected Member, 1884, 80.
- HESKETH, E., elected Graduate, 1879, 398.
- HESLOP ENGINE, *Paper* on the Heslop Engine, a chapter in the history of the steam engine, by H. A. Fletcher, 1879, 85.—Original specification of Heslop engine, 85.—General description, 86.—Engines known to have existed on the Heslop principle, 88.—Description of last surviving engine, 91.—Career of Heslop, 92.
- Discussion.*—Fletcher, H. A., The engine has now been removed to South Kensington Museum, 95.—Robinson, J., Object of loading both pistons with same weight, 94.—Paget, A., This arrangement only in engines having chain connections to the beam, 94.—Fletcher, H. A., Chain at that time only known mode, except Watt's, of connecting pistons with beam, 94.—Heslop engine built for driving machinery at Lowca Works, Whitehaven, 95.—Robinson, J., Members might visit engine at South Kensington, 95.
- HETHERINGTON, T. R., elected Member of Council, 1877, 25.
- Drilling Machines for Boiler Work, 1878, 581.
- Pressure-Intensifying Apparatus, 1878, 63.
- HEWETT, E. E., memoir, 1884, 473.

HICK, J., elected Vice-President, 1874, 26.—1875, 34.—1876, 26.

HIGH-PRESSURE BOILER AND ENGINE, 1877, 117. *See* Boiler and Engine, High-Pressure.

HIGH-PRESSURE BOILERS, 1879, 268. *See* Iron and Steel for Boilers.

HIGH-PRESSURE VESSELS, *Paper* on the construction of Vessels to resist High internal Pressure, by C. W. Siemens, 1878, 271.—Riveted joints are a source of weakness for high pressure, 271.—Principle of design for air reservoir at high pressure, 272.—Description of vessel, 272.—Testing of vessel, 272.—Bolts not to be made too tight, 273.—Same principle applied to hydraulic cylinders and accumulators, 274.—Ditto to marine boilers, 274.—Means of preventing galvanic action between copper and steel rings, 275.

*Discussion.*—Siemens, C. W., Each ring only requires one groove turning in it at each end, 275.—Crampton, T. R., Size of copper packing rings, 276.—Weems, W., Former compound cylinder for hydraulic pressure, 276; galvanic action between copper and steel is not of practical importance, 277; large hydraulic presses for wood carving, 277.—Tweddell, R. H., Leather or hemp is better than copper rings for joints, 277; advantage of long through bolts is doubtful, 278.—Bramwell, F. J., Through bolts are better than separate bolts or rivets, 278; means of testing uniformity of strain on bolts, 278; vacuum pump made without flanges, 278; marine boiler made in way described would have great advantage, 279.—Adamson, D., System described for marine boilers would fail from unequal expansion, 280; vessels would be better constructed of welded plates without joints, 281.—Olrick, L., Method of making boiler absolutely tight for ammonia, 281; great difficulty in making vessel air-tight, 281; galvanic action met with in copper tubes, 282.—Cowper, E. A., Means of detecting air leak, 283.—Weems, W., Difficulty in making vessel air-tight, 283.—Flannery, J. F., Application of system to marine boilers, 284; improvements in construction by welding plates, 284.—Paget, A., Question as to strength of metal strained in two directions at once, 284.—Boyd, W., Difficulty in keeping screws all equally tight, and preventing boiler rings from moving, 285.—Siemens, C. W., Leather and hemp joints would not stand very high pressure, 286.—Tweddell, R. H., Proposed leather or gutta-percha packing ring, instead of copper, 268.—Siemens, C. W., Copper packing rings answer remarkably well, 286; less length of joint in this construction of vessel than in riveted boiler, 287; means of overcoming unequal temperature for marine boilers, 287; welding causes much additional labour, 288; advantage of steel for construction of boiler shell, 288; less corrosion in steel of the intended temper than in very mild steel, 288; longitudinal strength provided for by separate bolts, 288; strain on metal in two directions has not been examined, 289.—Paget, A.,



## HIGH-PRESSURE VESSELS (continued).

Hydraulic cylinder has no tendency to burst endways, only so long as the ram is free to move, 289.—Siemens, C. W., No tendency to strain endways a cylinder standing on end, whether ram is free or not, 289; no tendency of boiler rings to slip transversely when boiler is arranged horizontally, 289.—Richardson, W., Remedy for preventing joints from becoming loose through over-heating, 290.

HIGSON, J., elected Member, 1879, 38.

HILDEBRANDT, J. A. R., Boiler and Engine, High-Pressure, 1877, 149.

HILL, J. K., elected Graduate, 1883, 594.

HILL, L., Governors, 1879, 418.

Steel Boiler Experiments, 1878, 241.

HILLER, H., elected Member, 1882, 145.

HILLS' DRY DOCKS AND ENGINEERING WORKS, Cardiff, 1884, 235, 362.

HIND, H., Tramways, Mechanical Traction, 1878, 437.

HIND, T. W., elected Member, 1876, 197.

HIRD, H., elected Member, 1874, 27.

Locomotive, Brown's Tramway, 1880, 68.

HIRN'S Telodynamic Transmission of Power by light wire rope, 1874, 56.

HISTORY OF ENGINEERING IN LEEDS, 1882, 266. *See* Engineering in Leeds.

HODBARROW IRON MINES, visited at Barrow meeting, 1880, 487.

HODGSON, C., elected Member, 1880, 9.

HODSON, R., elected Member, 1882, 254.

HOFFMANN'S KILN, 1875, 56, *Note*.

HOGG, W. T., elected Member, 1884, 80.

HOLLAND, C. B., elected Member, 1884, 80.

HOLROYD, J., elected Member, 1883, 179.

HOLT, F., elected Graduate, 1884, 80.

HOLT, W. L., Locomotive, Brown's Tramway, 1880, 64.

Tramways, Mechanical Traction, 1878, 434.

Tramways, Permanent Way, 1880, 213.

HOMERSHAM, S. C., Bath, Floating Swimming, 1875, 151.

Compressed-Air Machinery, 1874, 221.

Docks, Cardiff, 1874, 140.

Rock-Drill, Diamond, 1875, 109.

Hydraulic Machinery, Packing for, 1874, 140.

HOMOGENEOUS IRON, 1877, 48. *See* Iron, Homogeneous.

HONORARY LIFE MEMBERS, nomination of, 1878, 564.

HOOTON, W., elected Member, 1883, 309.

HOPKINS, J. I., decease, 1875, 3.—Memoir, 26.

HOPKINSON, JOHN, JUN., D. Sc., elected Member, 1874, 55.

Brakes, Effect of, upon railway trains, 1878, 626.

HOPKINSON, JOHN, Jun. (continued).

Electric Lighting, *First Paper* on Electric Lighting, 1879, 238.—Remarks, 250, 254, 259, 264.—*Second Paper*, 1880, 266.—Remarks, 283.

Flow of Solids, 1878, 335.

Safety Lamps, 1879, 229.

HOPKINSON, JOSEPH, elected Member, 1877, 72.

HORLOZ COLLIERY, visited at Belgian meeting, 1883, 513, 530.

HORNSBY, J., elected Member, 1880, 310.

Cultivation by Horses, 1880, 548.

HORNSBY, W., elected Member, 1880, 310.

HOSGOOD, T. H., elected Member, 1875, 35.

HOSKING, J., decease, 1875, 3.—Memoir, 26.

HOT-WATER ENGINES, tramways worked by, 1878, 405. *See* Tramways, Mechanical Traction.

HOWARD, H. J., elected Graduate, 1883, 594.

HOWARD, J. H., elected Graduate, 1879, 584.

HOWARD, J. W., elected Member, 1882, 15.

HOWDEN, J., Forging of Crank Shafts, 1879, 479.

HOWE, W., decease, 1880, 10.—Memoir, 6.—Remarks on his career, by D. Adamson, 23.

Engines, Winding, Direct-Acting, 1875, 240.

HOWELL, S. E., elected Member, 1877, 72.

HOWL, E., elected Member, 1882, 145.

HOWLETT, F., elected Member, 1877, 299.

HOYLE, F. E., elected Member, 1884, 1.

HUDSON, J. G., elected Member, 1882, 145.

HUDSON, R., elected Member, 1884, 408.

HUGHES, D. E., Iron and Steel, *Paper* on the Physical condition of Iron and Steel, 1884, 36.—Remarks, 52, 59.

Steel, Chernoff's papers, 1880, 233, 235, 237.

Steel, Hardening, &c., 1883, 68.

Steel, Tempered, *Paper* on the Molecular Rigidity of Tempered Steel, 1883, 72.—Remarks, 81, 91.

HUGHES, E. W. M., elected Member, 1881, 624.

HUGHES, G. D., Docks, Pumping Machinery, 1874, 159.

Rock-Drilling Machinery, 1877, 217.

Rules, 1884, 413.

South-Wales Mineral Wagons, 1884, 433.

Traction Engines in India, 1879, 527.

Valves, Safety, 1877, 189.

Water Meter, Barton and West's, 1879, 453.

- HUGHES, H., Compressed-Air Engines for Tramways, 1881, 665, 669.  
 Locomotive, Brown's Tramway, 1880, 57, 59.  
 Tramways, Mechanical Traction, 1878, 423, 425, 427, 428, 432.
- HUGHES' INDUCTION-CURRENTS BALANCE, 1880, 231.
- HUGHES' TRAMWAY LOCOMOTIVE, 1880, 57-62, 72.
- HULL, Docks and Works visited at Leeds meeting, 1882, 453, 468-471.
- HULSE, J. W., elected Graduate, 1883, 180.
- HULSE, W. W., Armour, Construction of, 1879, 73, 77.  
 Cutting of Metals, 1883, 261.  
 Friction at High Velocities, 1882, 149.  
 Research, Mechanical, 1879, 47, 48.  
 Rope Gearing, 1876, 395.  
 Rules, 1874, 31.—1877, 34.—1879, 41, 42, 45.—1880, 35.
- HUMPHRYS, J., elected Member, 1880, 185.  
 Gauge, Standard, for High Pressures, 1880, 474.  
 Steam-ship, *Paper* on the Steam-ship "City of Rome," 1880, 336.—  
 Remarks, 350, 358-361.  
 Valve-Gear, Joy's, 1880, 436.
- HUNT, R., elected Member, 1882, 475.
- HUNT, W., JUN., elected Member, 1874, 101.
- HUNTER, C. L., Anti-breakage hopper for coal-shipping, 1884, 231, 240, 241.
- HUNTER, W., elected Member, 1877, 72.  
 Expansion Gear, Correy, 1878, 525.
- HURMAN, J., elected Associate, 1874, 256.
- HUTCHINSON, E., Bridge, Erection of, *Paper* on the mode of Erection of the large  
 Iron Girder Bridge over the river Dal in Sweden, 1876, 46.  
 Plate Rolling Machinery, *Paper* on improvements in Machinery for  
 Rolling iron and steel Plates, 1880, 82.
- HUTCHINSON'S MULTIPLE DRILL, 1878, 565, 578.
- HYDRANT, Injector, 1879, 364. *See* Injector Hydrant.
- HYDRAULIC APPLIANCES :—  
 Accumulator, Intensifying, 1874, 168.  
 Accumulator, Steam, 1874, 34, 50.  
 Corrugating Press for sheet iron, 1874, 172.  
 Crane, Portable, 1874, 131, 138.—1884, 229.  
 Engine, Double-Acting, 1874, 49.  
 Engine, Three-Cylinder, 1874, 48.  
 Engine, Three-Cylinder, Brotherhood's, 1874, 47, 173, 224.  
 Flanging Machine, 1874, 170.  
 Hauling Engine, 1874, 130.  
 Hoist, 1874, 40, 133.  
 Jet-Pump, 1874, 292.

## HYDRAULIC APPLIANCES (continued).

Packing for Rams, &c., 1874, 50, 53, 138, 139, 140, 183, 190, 192, 194, 198.

Packing Presses, 1877, 349. *See* Presses, Hydraulic Packing.

Propulsion, 1874, 290.

Punching, Shearing, and Angle-Bar Cutting Machine, 1874, 171.

Reversing Gear, 1874, 35.

Riveting Machines, 1874, 46, 166, 167, 168, 176, 201.—1879, 271, 318.

Steering Gear, 1874, 37.

Tips for discharging Coal, 1874, 127.

Valves, 1874, 49, 53.

Winch, 1874, 40.

HYDRAULIC BRAKE for railway trains, 1878, 75. *See* Brakes.

HYDRAULIC ENGINES for mining purposes, 1880, 245. *See* Water-Pressure Engines.

HYDRAULIC FLANGING of Steel Plates cold, 1882, 528. *See* Flanging Steel Plates.

HYDRAULIC LIFTS, 1882, 119. *See* Lifts.

HYDRAULIC MACHINERY at Menier Chocolate Works, Noisiel, 1878, 551.

HYDRAULIC MACHINERY, MARINE, *Paper* on Hydraulic Machinery for steering, reversing, and discharging cargo &c. in steamships, by A. B. Brown, 1874, 33.—Steam machinery objectionable on shipboard outside main engine room, hydraulic machinery preferable, 33.—Steam accumulator avoiding dead weight, 34.—Hydraulic reversing gear for engines, 35.—Steam reversing gear, dispensing with accumulator, 36.—Hydraulic steering gear, 37.—Self-acting slide-valve for rudder to yield to excessive strains, 39.—Hydraulic hoist for discharging cargo, 40.—Hydraulic winch with adjustable throw of crank, 40.—Hydraulic swinging gear for jibs, 42.

*Discussion.*—Brown, A. B., Power of steering gear at extreme range of rudder, double of power in midships, 44.—Walker, B., Hydraulic winch less economical than steam winch, but has important advantage in rapidity, 44.—Brown, A. B., Hydraulic winch more economical and more under control than steam winch, 45; hydraulic pipes easier kept tight than steam pipes on shipboard, 45.—Tweddell, R. H., Relative economy of steam and hydraulic power, exemplified by hydraulic riveter, 46; fluctuation of pressure objectionable in steam accumulator, 46; hydraulic hoist involves increased friction from pulleys, 47.—Webb, F. W., Brotherhood's three-cylinder hydraulic engine applied successfully to a capstan, no packing required except the trunk leathers, 47.—Davey, H., Hemp packing for accumulator piston, 47; hydraulic winch compared with ordinary steam winch, 48; hydraulic engines with pair of double-acting cylinders at right angles found preferable to three single-acting rams, 49; circular disc-valves found to wear unequally and become leaky, 49; lignum-vitæ valve on brass face found most durable with moderate

## HYDRAULIC MACHINERY, MARINE (continued).

pressures, 49.—Brown, A. B., Steam accumulator preferable to dead-weight accumulator on shipboard, 50; hemp packing better than metallic for slow-moving piston of accumulator, 50; hemp packing better than leathers for stuffing-boxes of hydraulic machines, 51; hydraulic valves of specially hard gun-metal with very little wear, 52; hydraulic machines made automatic for use on shipboard by unskilled men, 52; throw of crank-pin can be easily changed while winch is at work, 52.—Tweddell, R. H., Hemp packing successful for hydraulic machinery where leathers failed, 53.—Webb, F. W., Phosphor-bronze, composition of, 53.—Ramsbottom, J., Means of passage for surplus water in reversing gear, 54.—Brown, A. B., Small reservoir of water, cut off from cylinder when under pressure, 54.—Siemens, C. W., Important advance made in adaptation of hydraulic power, 54.

HYDRAULIC MACHINERY, TOULON, *Paper on the Hydraulic Machinery in the iron shipbuilding department of the naval dockyard at Toulon*, by M. Berrier-Fontaine, 1878, 346.—Description of the works at Toulon, worked exclusively by hydraulic power, 347.—Means of supplying the machines with water, 350.—Means of supplying water to pumps as clean as possible, 352.—Reason why fixed riveting machine was not supplied from main pipe, 352.—Process of riveting as compared with processes of punching, shearing, and bending, 353.—Special differential accumulator provided for riveting machine, 354.—All other machines should be supplied from one pipe, 354.—Practical facilities for execution of work with hydraulic machinery, 355.—Excellence of work, 356.—Economy of working, as compared with machinery driven by shafting, 357.—Ditto, as compared with tools driven by independent engines, 358.—Much smaller boiler power required with hydraulic machinery, 358.—Table showing working of machines at Toulon, 360.—Maximum amount of work with the machines, 361.—Further economy in cost of working, 363.—Economy in consumption of power depends on machines having short stroke, 365.—Tappet gear for limiting waste of power, 367.—Waste of power nothing when maximum useful work is being performed, 368.—Diagram of resistance, taken from riveting machine, 369.—Ditto from punching machine, 370.—Ditto from angle-iron shearing machine, 371.—Ditto from plate shearing machines, 372.—Ditto from angle-iron bending machines, 372.—Ditto from plate-flanging machine, 372.

*Discussion*.—Robinson, J., Author unavoidably absent, 377.—Tweddell, R. H., Diagrams exhibited are diagrams of resistance, 377; final rise of pressure in hydraulic riveting is useful, 378; author's view as to thinning of plate by heavy final blow, 378; explanation of diagrams, 379; small pressure required for flanging, 382.—Anderson, J., Hydraulic machinery always preferable with intense pressure and short range of motion, 382.—



## HYDRAULIC MACHINERY, TOULON (continued).

Greig, D., How can cylinders be made for high pressures, 383.—Ellington, E. B., Cylinders made of cast iron are found to be strong enough, 383.—Ross, J. A. G., Unnecessary complication through separate supply of pressure water for each riveting machine and heavy press, 384; application of blow from accumulator appears doubtful advantage, 385; differential accumulator too complicated, 386.—Platt, J., Compound riveting machine with two pressures, not so good as a simple cylinder, 386; best pressure 1500 lb., 387; hydraulic pressure never causes rivet to washer, 387.—Gimson, J., Great waste of power with hydraulic machinery, 387.—Wilson, J. C., Work represented by highest part of indicator diagram is clinching of rivet, 389; results with Tweddell's portable riveter at Avonside Engine Works, Bristol, 389; arrangement for carrying die, 389.—Menclaus, W., Economy in moving power is of comparatively small importance, 390.—Tweddell, R. H., Uniform pressure is in general the best, 391; high-pressure is employed in portable riveters to get lightness, 391; waste of water is no greater in hydraulic riveting machines than in those worked by steam, 392; advantages of differential accumulator, 392; economy in use of two cylinders, 392; no undue waste of power with hydraulic tools, 393; rate of riveting per hour with hydraulic riveter, 394.

HYDRAULIC MACHINERY, WORKSHOP, *Paper* on the application of Water Pressure to driving machinery and working shop tools, by R. H. Tweddell, 1874, 166.—Hydraulic riveting, closing pressure increased by momentum of falling accumulator, 166.—Stationary hydraulic riveter, 167.—Portable hydraulic riveter, 167.—Intensifying accumulator, 168.—Hydraulic riveting plant for girder bridge work, 168.—Arrangement for avoiding heavy weight of accumulator, 169.—Hydraulic flanging machine, 170.—Hydraulic punching and shearing machine, 171.—Hydraulic corrugating press for sheet iron, 172.—Brotherhood's hydraulic three-cylinder engine, 173.—Application of hydraulic power to machinery, 173.—Advantage of hydraulic power, 174.—Economy of hydraulic transmission of power as compared with steam, 174.

*Discussion.*—Adamson, D., Hydraulic riveting consumes much more power than machine driven direct by rotary action, 176; steelyard riveting machine wastes no power, 176; hydraulic power suitable for shipbuilding and for riveting the very thick plates of marine boilers, 177.—Westmacott, P. G. B., Great advantage in pressure being kept on until rivet gets cool, 179; single-riveted boiler made steam-tight by hydraulic riveter without caulking, 179; loss of power in driving shafting, 180; air vessel employed successfully to avoid weight of accumulator, 180; working of three-cylinder hydraulic engine, 181.—Chapman, H., Hydraulic riveters very satisfactory for marine boiler work, 181; three-cylinder engine readily and quickly

## HYDRAULIC MACHINERY, WORKSHOP (continued).

taken to pieces for examination, 182.—Brotherhood, P., Construction of valves in hydraulic capstan, 183; bucket leathers better for packing than deep cupped-leathers, 183; metallic packing with india-rubber ring good for clean water, and very convenient, 184.—Ramsbottom, J., Hydraulic power not advantageous for planing or slotting tools, 185; successfully applied when large force is required to be transmitted to remote distances, 185; working of three-cylinder hydraulic engine, 186.—Cowper, E. A., Early substitute for accumulator, 186; hydraulic press applied to forging and welding iron, 186; relief valve not necessary in hydraulic capstan, 187.—Platt, J., Hydraulic riveter compared with rotary machine for loss of power, 188; working of hydraulic flanging press, 188.—Jackson, P. B., Construction of cylinders for hydraulic presses, with thin shell strengthened by two or three sets of hoops, 189.—Greig, D., Advantage in using high pressure of water for portable riveter, 189; hemp packing preferable to leather, 190.—Walker, B., Friction of ordinary shafting, 190; hydraulic presses worked with water-works pressure by means of rams of different areas, 191.—Richardson, J., Hydraulic riveting more economical than hand riveting, 191; cupped-leather packing worn out quickly with dirty water, 192; wear caused by sand getting behind leather packing when pressure is removed at end of stroke, 192; wear prevented by keeping pressure constantly on the leather by use of a relief valve, 193.—Cowper, E. A., Iron in water injures packing leathers, 194.—Richardson, J., Iron in water not of much consequence, 194.—Campbell, D., Oil used instead of water in cotton presses, 194; rams cased with gun-metal when worn, to prevent tearing of packing leathers, 194.—Wrightson, T., Friction of gland in accumulator, 194.—Tweddell, R. H., Advantage of hydraulic press for flanging plates, 195; comparative cost of work with portable hydraulic riveter, 196; hemp packing most suitable for hydraulic machines, more easily renewed than leather, 198; phosphor bronze found very durable for valves, 199; higher pressure of water used without causing trouble in keeping joints tight, 199; friction of shafting, percentage of engine power, 200; important to utilise moderate water-works pressure for driving hydraulic machinery by means of intensifying accumulator, 200.—Bramwell, F. J., Advantage of machine-riveting for marine boiler plates, 201; steam riveter with two cylinders, one for closing the plates, and the second for riveting, 202; boiler work should be steam-tight without caulking, 202; Hague's early attempt to drive machinery by exhaustion of air, 202; intensified pressure employed in manufacture of lead piping, 202.

HYDRAULIC PRESSES. *See* Presses, Hydraulic Packing. Pressure-Intensifying Apparatus. High-Pressure Vessels.

HYDRAULIC RIVETERS, Tweddell's, 1879, 271, 318.

## I.

IMPLEMENTS and Machinery for Cultivating Land by Horse-power, 1880, 529.  
*See* Cultivation by Horses.

IMRAY, J., elected Member, 1877, 299.

Injector Hydrants, 1879, 382.

Pump, *Paper* on the Helical Pump, 1874, 281.—Remarks, 289, 290, 291, 295.

INCORPORATION of Institution, 1878, 41, 114, 298, 557.

INDIA, Vertical-Action Steam-Dredger in, 1879, 534. *See* Dredger.

INDIA, Working of Traction Engines in, 1879, 494. *See* Traction Engines.

INDIA-RUBBER TYRES for Traction Engines, 1879, 494, 497, 505, 512. *See* Traction Engines.

INDICATORS, Speed Indicators for railway brake experiments, 1878, 470.

INDUCTION-CURRENTS BALANCE, Hughes', 1880, 231.

INGHAM, W., elected Member, 1882, 145.

INGLIS, J., elected Member, 1882, 145.—Decease, 1884, 3.—Memoir, 64.

INGLIS, W., Rope Gearing, 1876, 392.

INGOTS OF CAST STEEL, Structure of, 1880, 152. *See* Steel, Chernoff's Papers.

INJECTOR, *Paper* on the Automatic and Exhaust-Steam Injector, by A. S. Savill, 1884, 167.—Disadvantages of ordinary lifting injector, 167.—Automatic injector with split nozzle, 168.—Exhaust-steam injector, 169.—Special contrivance for feeding boilers at high pressures, 169.—Advantage for engines working intermittently, 170.—Mode of connection with exhaust pipe, 170.

*Discussion.*—Robinson, J., Advantage of split nozzle, 171; originally invented for exhaust-steam injector, 171; exhaust injector unavailable for locomotives except with additional appliance, 172; addition of live steam is required for higher pressures, 172.—Sharp, T. B., Working of injector is somewhat paradoxical, 172; exhaust injector not available for locomotives, 173; description of apparatus for same object, 173; apparatus for returning exhaust-steam into boiler, 174; objection to split nozzle with hinged flap, 176; injector with sliding nozzle divided transversely, 176; previous attempts to utilise exhaust steam, 177.—Tomkins, W. S., Reduction of back pressure in cylinders by use of exhaust injector, 178; superiority of exhaust injector to feed-water heater, 178.—Cochrane, C., Application of exhaust-steam injector, 178; rapidity of action, 179.—Bennett, P. D., Regulation of injector so as to work continuously, 179.—Gresham, J., Exhaust injector is most important improvement, 180.—Halpin, D., Action of injector is a thermodynamic question, 180.—Daw, J. G., Comparative results of injector and feed-water heater, 181.—Platt, J., Working of injector under unfavourable conditions, 181;

## INJECTOR (continued).

difficulty from grease carried into boiler, 181.—Anderson, W., Theory of injector, 182.—Schönheyder, W., Saving in feed-water, 182.—Alliott, J. B., Experiments on increase in temperature and quantity of feed-water, 182; automatic working of hinged flap, 183.—Savill, A. S., Small supplementary injector for feeding locomotives, 183; other contrivances for using exhaust steam are not automatic, 184; exhaust steam should be used to heat feed-water while cold, 185; successful working of exhaust injector on locomotives, 185; liability of piston injector to stick fast, 185; fuel saved by exhaust injector, 186.—Cochrane, C., Absolute saving by exhaust-steam injector, 186.—Savill, A. S., Economy in feed-water, 187; injector should not be too large, 187; diminished back-pressure on piston, 188; wear and tear of hinged nozzle, 188; proper connection of branch exhaust-pipe with main exhaust-pipe, 188.

INJECTOR HYDRANT, *Paper on Injector Hydrants for fire extinction*, by J. H. Greathead, 1879, 364.—Striking results in reducing loss by fire, from use of hydrants, 364.—Immense saving would result by their adoption in London, 365.—Injector hydrant, 365.—Other forms of the apparatus, 366.—Considerations as to how far this system is applicable to the Metropolis, 368.—Alternative schemes, (1) separate service for fire purposes, 370.—Ditto (2) existing service altered and hydranted, 371.—Ditto (3) new service of potable water having sufficient pressure for fire extinction, 372.—Ditto (4) injector-hydrant system, 373.—Advantages of the system, 376.—Tables, 377-378.

*Discussion.*—Bateman, F. J., Loss by fire in Manchester reduced to one-seventh by use of hydrants, 379; mode and cost of working with hydrants in Manchester, 379; system proposed could be applied with advantage to docks and warehouses, but not generally, 381; better to transform the bad existing system into a good one, 381; cost of doing so would be about one-half that of Mr. Greathead's system, 382.—Imray, J., Great expense in small houses from adoption of constant pressure, 382; best arrangement with Mr. Greathead's system for pumping the pressure water, 383.—Bateman, F. J., Cost of water fittings in cottages, 384.—Webb, F. W., Direct high-pressure system is the only one to depend on, 384.—Williams, R. P., Comparison of author's system with one which pumped all the water, 385; Table of sizes of pipes required, 386; cost of different systems, 387.—Crampton, T. R., Apparatus practically a success, 387; loss of energy might with care be considerably reduced, 388.—Gray, J. M., Question as to which pipe the water came from, 388.—Tweddell, R. H., Question was not so much one of economy as of extinguishing fires, 389; better to dispense with accumulator, except as a pressure regulator, 389; question of cost of different schemes, 389.—Cowper, E. A., Would the

## INJECTOR HYDRANT (continued).

boilers be always kept ready for full duty, 391.—Paget, A., Admirable system where there is an existing supply of high-pressure water, 391.—Greathead, J. H., Cost of altering pipes to make present supply of water sufficient would be enormous, 391; object of accumulator, 392; objections to direct high-pressure system, 393.—Webb, F. W., Objection does not exist at Euston, 393.

INSTONE, T., elected Member, 1883, 179.

INUNDATION, TYNEWYDD, 1877, 221. *See* Tynewydd Colliery Inundation.

IRON AND COAL INDUSTRIES in Liège district, 1883, 329. *See* Liège Iron and Coal Industries.

IRON AND STEEL, *Paper* on the Physical condition of Iron and Steel, by D. E. Hughes, 1884, 36.—Application of magnetic phenomena to examination of molecular changes, 36.—Results obtained by employing extremely feeble magnetising powers, 37.—Limits of softness and hardness in individual specimens, 38.—Theory of molecular freedom and rigidity, 38.—Description of magnetic balance, 39.—Remaining magnetism in specimens tested, 41.—Standard form of test-pieces necessary for comparative experiments, 41.—Influence of annealing, 42.—Annealing of Swedish iron, 42.—Time required for perfect annealing, 43.—Results of researches on annealing, 43.—Hardening effect of bending or other mechanical treatment, 44.—Effect of annealing upon iron and steel wires, 44.—Tempering, 45.—Tempering of crucible fine cast steel, 45.—Specimens of wires used, 46.—Results of mechanical, chemical, and physical tests, and conclusions thence drawn, 46.—Proposed dividing line between iron and steel, 49.—Relations of physical forces in iron and steel, 50.—Practical value of magnetic balance, 52.

*Discussion.*—Hughes, D. E., Original object of this research, 52; specimens of iron and steel can be tested by magnetic balance without breaking them, 53; testing of long pieces, 53; shape of magnetic coils, 54; practical utility of magnetic balance, 54.—Roberts, W. C., Value of induction balance, 55; determination of percentage of carbon in steel, 55; hardening influence of manganese, 55; distinction between tempering and hardening, 56.—Cowper, E. A., Difference between surface hardness and interior hardness, 56; drawing and annealing of wire, 57; mechanical test of hardness by file, 57; definition of tempering and hardening, 57.—Fell, J. C., Determination of coercitive force or retentive power in steel, 57; hardening effect of phosphorus, 58; enquiry how to obtain hardest possible temper for steel, 58.—Mair, J. G., Ordinary and chilled cast-iron, 59.—Paget, A., Meaning of tempering, 59.—Hughes, D. E., Hardening effect of manganese, 59; distinction between tempering and hardening, 59; tempering of thin flat surfaces and of wires, 60; mean error in specimens,



## IRON AND STEEL (continued).

60; magnetic value of steel, 60.—Cochrane, C., Question of further research, 60.

IRON AND STEEL FOR BOILERS, *Paper* on experiments referring to the use of Iron and Steel in high-pressure Boilers, by D. Greig and M. Eyth, 1879, 268.—Question is the means of forming strongest riveted joint, 268.—Rivet iron and steel, 268.—Ditto, tensile tests, 269.—Ditto, shearing tests, 269.—Rivets, tests of methods of riveting, 270.—Ditto, frictional resistance, 272.—Ditto, water-tightness, 272.—Riveted joints, tests of solid plates, 275.—Ditto, ditto, punched and drilled holes, 276.—Ditto, ditto, different modes of riveting, 278.—Ditto, ditto, size of rivets, 279.—Ditto, ditto, double-riveted lap-joints, 279.—Ditto, ditto, butt-joints, 280.—Ditto, ditto, boilers after manufacture, 282.—Ditto, ditto, fire-box sides, 282.—Ditto, ditto, boiler shells, 285.—Ditto, ditto, boilers complete, 287.—Conclusions, 289.—Appendix, Tables showing results of experiments, 292.

*Discussion.*—Greig, D., Butt-joint with two cover-plates is best, 303; portable engines should not have iron boilers, 303.—Eyth, M., Butt-joint tested for water-tightness, 303.—Webb, F. W., Standard joints used on London and North Western railway, 304; improvement by taking scale off joint, 305; experiments hardly fair for lap-joints, 305.—Unwin, W. C., Defects in mechanical experiments, 306; uncertainty as to experiments on drilling and punching, 307; joints in testing machine not under same conditions as in actual work, 308; doubtful importance of question as to bearing surface, 309; influence of pressure used in riveting upon strength of joint, 309; stress on plates in oblique direction, 311; in stayed surfaces different stays take different pressures, 312.—Cowper, E. A., Each stay takes same amount of pressure if properly spaced, 313; bending of plates at joints, 314.—Unwin, W. C., Influence of size of rivet-holes on plates bending, 314.—Cowper, E. A., Size of holes has a most material effect, 314; pressure used for riveting has direct effect, 314.—Aveling, T., Best form of butt-joints with one cover, 315.—Fox, S., Boiler shell will soon be made in one piece, 315.—Cochrane, C., Butt-joints not desirable for externally-fired boilers, 316.—Hall, W. S., Author's results as to leakage differ from those of Mr. Fletcher in 1876, 316.—Cowper, E. A., Mr. Fletcher never burst a boiler with water pressure, 317.—Platt, J., Mr. Fletcher employed enormous pumping power, 317.—Marten, E. B., Boilers burst from injury by fire, and by expansion and contraction, 317.—Tweddell, R. H., Hydraulic riveting with impact accumulator is shown to be best, 318; temperature of rivets important, 319.—Platt, J., Had merely riveted the samples supplied, 319.—Crampton, T. R., Iron will have to give way to steel in nearly all cases, 320.—Bromley, M., Prefers steel boilers, provided trained steel-boiler makers can be got, 320.—Paxman, J. N.,

## IRON AND STEEL FOR BOILERS (continued).

Asks author's experience as to steel plates for fire-boxes, 321; has given up angle-iron and steel angles for locomotive boilers, 322; finds no difficulty in getting men who can make steel boilers, 322; were the steel plates as rigid as iron, 322.—Crampton, T. R., Has never used angle-iron in a locomotive boiler, 322.—Greig, D., Specimen plates were tested straight, 323; failure of stays due to expansion and contraction &c., 323; has overcome difficulty in getting men to use steel plates, 324; experience with steel fire-boxes, 324; steel less flexible than iron, 324; angle-iron can now be done away with, 324.—Crampton, T. R., Angle-iron could have been done away with thirty years ago, 324.—Eyth, M., Mode used for calculating strain on zigzag riveting, 325; in strength of riveted joints friction has been allowed for, 325; meaning of the word "burr," 325.—Paxman, J. N., Percentage of carbon in steel boiler-plates, 326.—Eyth, M., Increase found in resistance of rivet with increase of pressure, 326.—Robinson, J., Difficulties which prevented boilers from being made without angle-iron thirty years ago, 327; question now under investigation by Research Committee, 327.

IRON AND STEEL FOR SHIPS, 1881, 553. *See* Ships.

IRON AND STEEL WORKS, visited at Summer meeting, Belgium: Angleur, 1883, 513, 537; Cockerill, 511, 526-527; Ougrée, 513, 538, 541; Sclessin, 513, 535.

IRON, HOMOGENEOUS, *Paper* on Homogeneous Iron, and the degree of homogeneity to be expected in iron produced by various systems of puddling and subsequent working, by H. Kirk, 1877, 48.—Difficulty in preventing variation in quality of iron, 48.—Definition of the word "puddling," 48.—Meaning of homogeneous iron, 49.—Homogeneous iron not necessarily pure, but of same nature throughout, 50.—High strength and ductility combined, 51.—Experiments on strength of steel, 51.—Description of the process of puddling, 52.—Effects of carbon with other elements in iron, 53.—Experiments on puddling iron from hæmatite ores, 54.—Results of testing samples, 55.—Analysis of samples, 56.—Increase of strength in iron with increase of carbon, 57.—Mixture of iron and cinder, not compatible with homogeneity, 57.—Most valuable iron is that which is purest, along with sufficient carbon to impart strength, 58.—Old puddling process better than boiling process for ensuring homogeneity, 58.—Double furnaces with mechanical rabblers objectionable, 59.—Casson-Dormoy furnace, 60.—Maudslay or Pernot furnace, 61.—Furnace revolving on a horizontal axis best, 61.—Danks furnace does not give much promise of homogeneity, 61.—Spencer furnace shows better results from working, 62.—Crampton furnace seems to give greatest promise of homogeneity, 62.—Puddled-bar system is the outcome of an effort to obtain uniformity, 62.—Tests of hoop

## IRON, HOMOGENEOUS (continued).

iron and steel, 65.—Tests of steel and iron bars, 66, 67.—Tests of iron bars produced by five different methods of working, 68.—Analyses of bar iron, 69.

*Discussion.*—Kirk, H., Homogeneous iron or mild steel is the best form of iron, but difficulty in the way of its manufacture and use, 73; impossible to ensure perfect homogeneity in any furnace, 74; the less phosphorus there is in pig and cast iron, the more carbon remains in it, 75; fibre in bar iron frequently produced by cinder, but retention of cinder in high-class iron a great mistake, 76; best quality of iron found to be the cheapest in use, 78.—Siemens, C. W., Crystalline fracture in puddled iron not antagonistic to toughness, 78; as much puddled-bar or nearly as much should be obtained as weight of pig-iron put into furnace, 78; means of producing wrought-iron direct from ore, 79; cause of small proportion of phosphorus in iron produced by direct process in revolving furnace, 80.—Bell, I. L., Presence of cinder could not increase toughness or improve quality of iron, 80.—Siemens, C. W., Greater yield of rotary puddling furnace due to flame being less cutting and less oxidising, 81.—Bell, I. L., Not any neutral flame at temperature of puddling furnace, 82; means of reducing phosphorus, simply a question of temperature in furnace, 82.—Crampton, T. R., Good yield obtained with Price's double-puddling furnaces at Woolwich, 83; least oxidation of iron in the dust-fuel furnace, 84.—Cowper, E. A., Approach to a neutral flame obtained in the Siemens gas furnace, 85; means of getting rid of sulphur and phosphorus in puddling, 86.—Head, J., Meaning of the term homogeneous, 87; iron breaking with fine grain and steely fracture better than with fibrous fracture, 87; nature of fibre in malleable iron, 88; plates stronger in the direction of rolling than across, 89.—Kirk, H., Cinder existing in iron reduces the strength, 90; more cinder in puddle balls from rotary furnaces, causing increase of yield, 90.

IRON MINES, Mwyndy, near Llantrissant, 1874, 247.—Furness Hæmatite, 1880, 363, 484, 485, 487. *See* Mines.

IRON WORKS, Cyfarthfa, 1874, 239.—1884, 358, 377–380.

Dowlais, 1874, 239.—1884, 358, 374–377.

Ebbw Vale, 1884, 359, 386–392.

Gartsherrie, 1879, 575.

Govan, 1879, 571.

North British, 1879, 575.

Rhymney, 1884, 359, 381–386.

Round Oak, 1876, 336.

Summerlee, 1879, 575.

Woodside, 1876, 337.

## J.

- JABLOCHKOFF CANDLE for electric lighting, 1878, 538, 540. *See* Electric Lighting.
- JACKS, T. W. M., elected Member, 1884, 80.
- JACKSON, E., elected Associate, 1884, 409.
- JACKSON, F. W., elected Member, 1881, 409.
- JACKSON, H. J., elected Member, 1876, 347.—Memoir, 1884, 473.
- JACKSON, P. R., Hydraulic Machinery, Workshop, 1874, 189.
- JACKSON, W., elected Associate, 1882, 476.
- JACOBS, C. M., elected Member, 1876, 57.  
Boiler Corrosion, Marine, 1884, 343.
- JAKEMAN, C. J. W., elected Member, 1878, 107.  
Tramways, Mechanical Traction, 1878, 420.
- JAMES, C., elected Member, 1877, 299.  
Presses, Hydraulic Packing, 1877, 362.
- JAMES, JABEZ, decease, 1884, 3.—Memoir, 64.  
Steel, Chernoff's papers, 1880, 236, 240.
- JAMES, JOHN, decease, 1874, 2.—Memoir, 21.
- JAMES, J. W. H., elected Member, 1877, 72.
- JAMESON, G., elected Member, 1879, 398.
- JAMESON, J., elected Member, 1881, 163.  
Coke, *Paper* on Improvements in the Manufacture of Coke, 1883, 275.—Remarks, 300.  
Printing Machinery, *Paper* on Printing Machinery, 1881, 511.—Remarks, 523, 524, 525.
- JAMIESON, J. L. K., decease, 1884, 3.—Memoir, 65.  
Forging of Crank Shafts, 1879, 472.  
Votes of thanks, Replies to, 1879, 564, 565; to President, 566.
- JARDINE, J., elected Member, 1882, 475.
- JEBB, G. R., elected Member, 1876, 197.
- JEFFERIES, J. R., elected Member, 1880, 489.
- JEFFERISS, T., elected Member, 1881, 9.
- JEFFREYS, E., Rules, 1874, 29.
- JEFFREYS, E. H., elected Graduate, 1877, 299.
- JEMSON, J., elected Member, 1876, 57.
- JENKIN, H. C. FLEEMING, F.R.S., elected Member, 1875, 189.
- JENKINS, A., elected Member, 1884, 408.
- JENKINS, R., elected Graduate, 1880, 10.
- JENSEN, P., elected Member, 1878, 107.
- JESSOP, J., elected Member, 1878, 293.—Decease, 1884, 3.—Memoir, 66.
- JET PUMP, HYDRAULIC, 1874, 292.

JOHN, W., Riveted Joints, 1881, 271.

Ships, Iron and Steel for, 1881, 564.

JOHNSON, C. M., elected Member, 1882, 15.

JOHNSON, S., elected Member, 1882, 255.

JOHNSON, S. W., elected Member of Council, 1884, 21.

South-Wales Mineral Wagons, 1884, 429.

JOINTS for vessels to resist high internal pressure, 1878, 272, 277, 281, 286.

JOINTS, Riveted. *See* Riveting.

JOLIN, P., elected Member, 1882, 145.

JONES, A. F., elected Graduate, 1878, 108.

JONES, F., elected Member, 1884, 408.

JONES, F. R., elected Member, 1878, 558.

JONES, HARRY E. (London), elected Member, 1878, 558.

JONES, HERBERT E. (Manchester), elected Member, 1881, 409.

JONES, J., decease, 1878, 21.—Memoir, 10.

JONES, S. G., elected Member, 1882, 475.

JONES, W., elected Member, 1877, 72.

JORDAN, E., elected Member, 1883, 309.

JORDAN, H. K., Tynnewydd Colliery Inundation, 1877, 232.

JORDAN, T. B., Rock-Drilling Machinery, *Paper* on Rock-Drilling Machinery, 1874, 77.—Remarks, 92, 94, 96.

JORDAN'S Air-compressing pump, 1874, 88.—Stand for rock-drilling machine, 1874, 83.—Flange drilling and turning machine, 1878, 568, 576, 577.—Boiler-shell drilling machine, 1878, 571, 575, 576, 577.

JOSSE, H., elected Member, 1884, 198.

Joy, D., elected Member, 1880, 185.

Cold Air, Machines for producing, 1881, 128.

Hammers, Power Hammers with Movable Fulcrum, 1882, 210.

Locomotives, Compound, 1883, 452.

Valve-Gear, *Paper* on a new reversing and expansive Valve-Gear, 1880, 418.—Remarks, 430, 449–454.

JÜNGERMANN, C., elected Member, 1878, 558.

JUTE MACHINERY, *Paper* on the manufacture of Jute, by W. Fleming, 1880, 380.—

Origin and development of jute manufacture, 380.—Growth of jute, and “retting,” 381.—Softening, 381.—Breaker card, 382.—Finisher card, 384.

—Drawing frame, 385.—Second drawing frame, 387.—Roving frame, 387.

—Spinning frame, 389.—Sizes of yarn, 390.—Uses of jute, 391.

*Discussion.*—Fleming, W., Statistics of jute manufacture, 392.—Routledge, T., Use of jute ends for paper-making, 392.—Cochrane, C., Sack-making and sewing machines, 392.—Cowper, E. A., Length of jute fibre, mode of retting, and feeding of breaker card, 392; length of fibre in drawing-frame, and twisting of roving, 393.—Paget, A., Original



## JUTE MACHINERY (continued).

natural length of jute fibre, and length in yarn, 393.—Cowper, E. A., Length of long and short fibres, 393.—Fleming, W., Bleaching of jute without loss of strength, 393; sack-sewing by machinery, 394; retting in cold water, 394; jute cuttings for paper-making, 394; feeding of breaker card, 394; original and ultimate lengths of fibre, 394; dyeing of jute, 395.

JUTE WORKS, visited at Barrow meeting, 1880, 480.

JUSTICE, H. R., elected Member, 1884, 80.

## K.

KEELING, H. H., elected Member, 1882, 145.

KEEN, F. W., elected Graduate, 1883, 180.

KELSON, F. C., Valve, Circular Slide, 1877, 205.

KENDAL, R., elected Member, 1881, 409.

KENNEDY, A. B. W., elected Member, 1879, 38.—Honorary Life Member, 1883, 54.

Brakes, Effect of, upon railway trains, 1878, 487.—1879, 199.

Electric Lighting, 1879, 259.

Friction at High Velocities, *First Report* on, 1883, 660-665.

Locomotives, Compound, 1879, 360, 362.

Riveting, *Paper* on results of experiments on Riveted Joints, Series I-VIII.

made for the Institution of Mechanical Engineers, 1881, 205.—

Remarks, 258, 287.—*Report* on further experiments on Riveted Joints,

Series IX, 1881, 712.—*Report* of experiments on Riveted Joints

with high bearing pressures, Series X, 1882, 138.

Shafting, Strength of, 1883, 220, 224.

Steel, Hardening &c., 1882, 38.

Steel, Tempered, Molecular Rigidity of, 1883, 91.

Traction Engines in India, 1879, 528.

Water-Power Engines, 1879, 489.

Water-Pressure Mining Engines, 1880, 260, 261.

KENNEDY'S BOILER-SHELL DRILLING MACHINE, 1878, 571, 575, 576.

KENNEDY'S SPIRAL PUNCH, 1878, 235, 239, 243.

KENRICK, G. H., elected Member, 1875, 189.

KERMODE, C. C., elected Member, 1878, 31.—Decease, 1879, 22.—Memoir, 10.

KERR, J., elected Member, 1884, 199.

Portable Railways, 1884, 139, 149.

KERSHAW, J., Railway Traffic, Cost of, 1878, 207, 208.

KERSHAW, T. E., elected Member, 1884, 408.

KESSLER, E., elected Member, 1880, 310.

KILNS for Portland Cement, 1875, 49.—Hoffmann's, 1875, 56, *Note*.

- KING, C. P., elected Graduate, 1884, 409.
- KIRK, A. C., Cold Air, Machines for producing, 1881, 128.  
Marine Engine, 1881, 479.
- KIRK, H., elected Member, 1877, 26.  
Iron, Homogeneous. *Paper* on Homogeneous Iron, and the degree of homogeneity to be expected in iron produced by various systems of puddling and subsequent working, 1877, 48.—Remarks, 73, 90.
- KIRKALDY, J., elected Member, 1884, 1.
- KIRKWOOD, J., elected Member, 1875, 314.
- KIRKWOOD, T., elected Member, 1882, 255.
- KIRTLEY, M., decease, 1874, 2.—Memoir, 22.
- KITSON, F. W., elected Member of Council, 1875, 34.—Decease, 1878, 21.—Memoir, 11.
- KITSON, J. H., elected Member of Council, 1880, 24.—1883, 53.  
Boiler Feeder, Fromentin Automatic, 1882, 488, 489, 490.  
Cutting of Metals, 1883, 262.  
Valve-Gear, Joy's, 1880, 435.
- KITSON, J., JUN., Testing Machine, Single-Lever, 1882, 392.
- KLEIN, T., elected Member, 1874, 55.
- KLOTZ SAFETY VALVE, 1877, 180, 194, 195. *See* Valves, Safety.
- KNIGHT, J. H., elected Associate, 1875, 315.
- KNIGHT, R. V. J., Riveting, *Memorandum* of experiments on Lap-Joints, with rivets of different sizes, 1881, 720.
- KNOTTERS for Paper Making, 1876, 141, 159, 160.
- KNOWLES SUPPLEMENTARY GOVERNOR, 1884, 157. *See* Engine Recorder.
- KÖRTING'S INJECTOR, 1884, 176, 185.
- KORTRIGHT, L. M., elected Graduate, 1877, 300.  
Raising of Wreck, *Paper* on the appliances and operations for Raising the wreck "Edith" at Holyhead, 1878, 116.—Remarks, 127.
- KRAUSS' tramway locomotive, 1878, 415. *See* Tramways, Mechanical Traction.

## L.

- LA GILEPPE RESERVOIR DAM, visited at Summer meeting, Belgium, 1883, 516.  
—Description, 553.
- LAING, A., elected Member, 1881, 624.
- LAIRD, H. H., elected Member of Council, 1876, 26.—1878, 29.
- LAKE, W. R., elected Member, 1883, 179.
- LALANDE BATTERY, 1884, 451, 457, 459, 467, 468. *See* Railway Electric Signals.
- LA LIÈVE FLAX AND TOW MILLS, visited at Summer meeting, Belgium, 1883, 517.—Description, 565.
- LAMBERT, W. B., decease, 1875, 3.—Memoir, 26.

- LAMBOURN, T. W., elected Member, 1878, 107.
- LAMPS, SAFETY, 1879, 219. *See* Safety Lamps.
- LANCASHIRE BOILER, 1876, 59. *See* Boiler, Lancashire.
- LANCASTER, J., memoir, 1884, 402.
- LANDER, P. V., elected Graduate, 1883, 594.
- LANDORE SIEMENS-STEEL WORKS, Siemens-Martin steel works, blast furnace, large regenerative hot-blast stoves, and fire-brick works, 1874, 241.
- LANDORE TIN-PLATE WORKS, refinery, forge, rolling mill, and preparing and tinning plates, 1874, 246.
- LANGDON, W., elected Member, 1881, 409.
- LANGE, F. G., Wool-Combing Machinery, 1882, 228.
- LANGE, F. M. T., elected Member, 1881, 163.  
Wool-Combing Machinery, *Paper* on Wool-Combing by modern machinery, 1882, 214.—Remarks. 225. 227.
- LANGE, H. L., elected Member, 1877, 165.
- LANGLEY, A. A., elected Member, 1879, 155.  
Dredger, *Paper* on the Bazin system of Dredging, 1882, 100.—Remarks, 105, 115, 116.
- LANGLEY BARONY LEAD MINES, visited at Summer meeting, Newcastle, 1881, 618.
- LAPAGE, R. H., elected Member, 1879, 583.
- LAP-JOINTS, *Memorandum* of experiments on Lap-Joints, with Rivets of different sizes, by R. V. J. Knight, 1881, 720.
- LARSEN, J. D., elected Member, 1879, 398.  
Locomotive, Brown's Tramway, 1880, 69.  
Tramways, *Paper* on Permanent Way for street Tramways, with special reference to steam traction, 1880, 188.—Remarks, 221.
- LARSEN'S permanent way for Tramways, 1880, 192, 194. *See* Tramways, Permanent Way.
- LARTIGUE, Delebecque, and Banderali's railway brake apparatus, 1878, 554.
- LAVALLEY, A., elected Member, 1881, 409.
- LA VESDRE WOOL-COMBING AND SPINNING WORKS, visited at Summer meeting, Belgium, 1883, 515.—Note on Works. 548.
- LAWRENCE, H., Engines, Winding, Direct-Acting, 1875, 236.  
Mining Machinery, 1882, 369.
- LAWS, W. G., elected Member, 1874, 256.
- LAWSON, J. I., elected Graduate, 1881, 10.
- LAWSON, F. W., elected Member, 1882, 145.
- LAYCOCK, W. S., elected Member, 1883, 309.
- LEA, H., Friction Experiments, 1883, 655.
- LEAD PROCESSES, *Paper* on some recent Improvements in Lead Processes, by N. C. Cookson, 1881, 527.—Stationary nature of lead processes, 527.—Pattinson desilverizing process, 528.—Rozan steam desilverizing process, 529.—Advantages and disadvantages of ditto, 532.—Zinc process of

## LEAD PROCESSES (continued).

desilverizing, 532.—Rolling or milling of lead, 534.—Circular knives for dressing off finished sheet, 535.

*Discussion.*—Pattinson, H. L. Principle of his father's process, 536.—Cowper, E. A., Rozan process in operation, 436.—Rich, W. E., Low specific heat and latent heat of lead, 536.—Cookson, N. C. Corroboration from practice, 537; Rozan process makes softer and purer lead than Pattinson process, 537.

LEAKE, A. H., elected Member, 1884, 1.

LEAVITT, E. D., JUN., elected Member, 1883, 33.

LEEDS ENGINEERING, HISTORY OF, 1882, 266. *See* Engineering in Leeds.

LEEDS MEETING, 1882, 251.—Reception, 251.—Deaths of W. Menelaus and C. P. Stewart, 253.—Business, 254.—Votes of thanks, 258.—Excursions, &c., 451.

LEEDS, Works visited at Summer meeting, Leeds, 1882, 451, 454–465.

LEES, J., elected Member, 1874, 101.

LEIGH, E., decease, 1877, 3.—Memoir, 19.

LEIGH, J. D., decease, 1879, 22.—Memoir, 11.

LENNON, J., elected Member, 1883, 309.

LÉON, A., elected Member, 1882, 16.

LEPAN, R., elected Graduate, 1884, 409.

LESLIE, J., elected Member, 1883, 309.

LEWIS, G., elected Member, 1878, 293.

Presses, Hydraulic Packing, 1877, 372.

LEWIS, H. W., elected Member, 1884, 80.

LEWIS' MERTHYR COLLIERY, visited at Summer meeting, Cardiff, 1884, 357, 370.

LEWIS, W. T., elected Member, 1884, 199.

LIBRARY, DONATIONS TO, 1874, 2.—1875, 4.—1876, 3.—1877, 3.—1878, 25.—Arrangement for taking books out, 564.—Donations to, 1879, 30.—Scheme for lending books, 1879, 34.—Donations to, 1880, 18.—Bequest of £100 from late Robert Napier, 1880, 186.—Donations from R. A. McLean, Waring Brothers, and G. B. Rennie, 1880, 311.—Napier bequest, 1881, 13, 18.—Donations to, 1881, 20.—1882, 24.—1883, 46.—1884, 14–19.

LIÉGE IRON AND COAL INDUSTRIES, *Paper* on the History of the Iron and Coal Industries in the Liège district, by E. de Laveleye, 1883, 329.—Primitive manufacture of Malleable Iron, 329.—Oldest blast-furnace, 330.—Coke for blast-furnaces, 330.—First puddling furnace and rolling mill, 331.—Smelting of oolitic ironstone, 331.—Blowing engines, hot blast, and Bessemer steel, 331.—Cemented steel, 332.—Present position of iron trade, 332.—Statistics of progress, 333.—Discovery of Coal, 335.—Earliest modes of working by adits, 335.—Shafts, tubbing, and sinking by compressed-air, 336.—Winding engines, 337.—Ladders, cages, and man-engines, 338.—

## LIÉGE IRON AND COAL INDUSTRIES (continued).

Safety lamps, 338.—Mechanical ventilation, 340.—Pumping engines, 341.  
 —Statistics of progress, 342.—Cost of pumping, 343.—Coking, 343.—  
 Sources of information, 343.

LIÉGE, Meeting in Liège, 1883, 307. *See* Belgian Meeting.

LIFE MEMBERSHIP. *See* Rules.

LIFTS, *Paper on Hydraulic Lifts for passengers and goods*, by E. B. Ellington, 1882, 119.—Introduction of lifts worked by mechanical power, 119.—CHAIN lifts, 119.—Power employed, and attendant risks, 121.—Hydraulic jigger lift for high pressures, 122; ditto for moderate pressures, 123; ditto for low pressures, 124.—DIRECT-ACTING HYDRAULIC lifts, 125.—Conditions affecting low-pressure lifts, 125.—Use of counterbalance chains and weights, 126.—Tommasi's balancing arrangement, 127.—Author's HYDRAULIC BALANCE lifts, 128.—Mode of action, 129.—Economy of hydraulic lifts, 131.—Hydraulic lifts of large power, 134.—Wagon lift at Seacombe pier, 134; ditto at Whitecross Street station, 134.—Table of results of experiments on hydraulic lifts, 136.—Mode of estimating efficiency, 137.

*Adjourned Discussion.*—Walker, B., Hydraulic direct lift is best and safest, 152; safety apparatus can be made quite reliable, 152; worm gear properly applied most valuable, 152; satisfactory use of belt for driving hoists, and gas engine, 153; advantage of plate chains, 153.—Colyer, F., Chain lift unsafe for workmen, 154; use of safety apparatus for goods lifts, 154; duplicate wire ropes, 154; attachments of chains to cages, 155; loss in lowering steam-lifts by steam is small, 155; special valve-box for lifts, 155; introduction of hydraulic-power chain-hoists, 155; pulleys should be of large diameter for wire ropes, 156; no practical limit to height for direct-acting ram-lifts, 156; varying strain upon ram, 156; attachment of counterbalance chains to sides of cage, 157; speed of working for passenger lifts, 157; friction of ram in hydraulic lifts, 158; hydraulic lifts at Seacombe pier, and at Anderton canal, 158; loss of power from friction of worm gearing, 159; danger of belt gear, and of pitch chains, 159.—Davis, A., Ellithorpe's safety lift with air-tight well, 159.—Tweddell, R. H., Safety of chains for lifts, 160; direct-acting hydraulic lift requires no head room, 160; objection to hemp-packing serving as brake, 161; low useful effect with wire ropes, 161; speeds of working lifts, 161; ratio of length to diameter of ram, 161; cyclic elevator with continuous motion, 161; Bramah's proposed telescopic lift, 162.—Rich, W. E., Number of packings in hydraulic lifts, 162; danger from cylinder bursting in direct ram-lift, 163; prohibition against persons travelling in goods lifts, 163; objection to safety apparatus, 163; efficiencies of lifts, 164; relation between efficiency and speeds of working, 165.—Head, J.,



## LIFTS (continued).

Danger attending direct-acting steam lifts, 165; colliery winding, 166; overhead winding engine for wire-rope lift at blast-furnaces, 166.—Ellington, E. B., Safety of direct-acting ram-lift, 167; failures of safety apparatus, 167; use of gas or steam engines for getting hydraulic power, 167; Seacombe hydraulic lifts distinct from Anderton canal lift, 168; limit to height of direct-acting ram-lift, 168; use of chain lift only where direct-acting ram impracticable, 168; efficiency, speed, and relative friction, in various types of lifts, 169; ratio of length to diameter of ram, 171; solid and hollow rams, 172; danger of cyclic lift, 172; short-link chain preferable to plate chain, 172; defective principle of chain-balanced direct lift, 172; counterbalance weights and chains unsuitable for high-pressure lifts, 173; advantages of hydraulic balance, 173; higher speed with same quantity of water, 174; friction of glands, 174.—Westmacott, P. G. B., Comparative safety of chain lift and direct-acting hydraulic lift, 175; arrangement of safety apparatus for chain lift, 175; risk of accident to hydraulic lift, 176; situation of machinery, importance of light, 176.—Ellington, E. B., Reasons of less liability to accident with hydraulic-balance lift, 176; automatic hydraulic brake to check rapidity of descent, 177.

LIGHTFOOT, T. B., elected Member, 1880, 9.

Cold Air, *Paper* on Machines for producing Cold Air, 1881, 105.—Remarks, 125, 130, 132.

Water-Pressure Mining Engines, 1880, 262.

LIGHTING, ELECTRIC, 1878, 529, 553.—1879, 238.—1880, 266. *See* Electric Lighting.

LIMESTONE PIT, Messrs. Dixon and Burne's, Dudley Port, 1876, 338.

LINDAL MOOR IRON MINES, visited at Barrow meeting, 1880, 484.

LINDSAY, LORD, nominated Honorary Life Member, 1878, 564.

LIQUID FUEL, 1884, 272. *See* Petroleum Fuel in Locomotives.

LISHMAN, T., elected Member, 1876, 347.

LIST, J., elected Member, 1881, 409.

LIVESEY, J. M., elected Associate, 1884, 199.

LLEWELLYN, W. H., decease, 1878, 21.—Mémorial, 12.

LLOYD, F. H., Tuyere, Open Spray, *Paper* on the Open Spray Tuyere and other blast-furnace tuyeres, 1876, 350.—Remarks, 359, 368, 370.

LLOYD, R. S., elected Member, 1882, 145.

LLOYD, SAMFSON, notice of decease, 1874, 253.—Resolution of meeting, 255.—Mémorial, 1875, 27.

Rules, 1874, 30.

LLOYD, S. Z., Bridge, Erection of, over the river Dal, 1876, 53.

Hammers, Power Hammers with Movable Fulcrum, 1882, 212.

Puddling, Mechanical, 1876, 275.

LLOYD'S BUTE PROVING HOUSE, Cardiff, 1884, 364.

LLWYNPIA COLLIERY, Glamorgan Coal Co.'s, Rhondda Valley, 1874, 234.—

Visited at Summer meeting, Cardiff, 1884, 357, 372.

LOAN, M. H., decease, 1882, 17.—Mémorial, 9.

LOCKHART, W. S., elected Member, 1879, 38.

LOCK GATES, Cardiff Docks, 1874, 122.

LOCKYER, N. J., elected Graduate, 1881, 164.

LOCOMOTIVE, BROWN'S TRAMWAY, *Paper on Brown's Tramway Locomotive*, by B. C. Browne, 1880, 44.—Requirements for a tramway locomotive, 44.—Extent of adoption of Brown's engine, 44.—Description of engine, 45.—Distribution of steam, 46.—Valve-gear, 48.—Dimensions and particulars of engines, 49.—Working cost, 50.—Strasburg engines, 51, 54.—Hamburg engines, 53, 55.—Comparison with other systems, 55.—Combined car and engine, 56.—Distinctive character of tramway locomotives, 56.

*Discussion.*—Browne, B. C., Additions necessary to meet Board of Trade requirements, 57.—Hughes, H., Disadvantage of high steam pressure in streets, 57; construction of boiler and firebox, position of cylinders, use of spiral bearing springs, 58; mode of condensing exhaust steam, 59; consumption of fuel, and cost of working, 60; bad state of early tramways, 60; size of wheels, 60; working parts should be few and simple, 61; injury to his own engines in Paris from presence of oil in boiler, 61.—Winby, F. C., Features desirable in tramway locomotive, 63; condensing arrangement, 63.—Schönheyder, W., Objection to use of dog-link, 63; weakness of Brown boiler, 64.—Holt, W. L., Cost of working in Strasburg, 64; in Hamburg and Paris, 65; objections to working a tramway engine by only one man, 65; advantage of machinery being raised from ground, 66; effect of oil and tallow in boilers, 67.—Crompton, R. E. B., Not desirable to diminish piston-speed in tramway engines, 67; high pressure not objectionable, 67; inadequate condensation of exhaust steam, 67; tramway engine should have vertical boiler, and be cheap, 68.—Hird, H., Valve-gear affected by vertical play of axles, 68; disadvantage of larger wheels, 68.—Larsen, J. D., Injury to engines due to defective tramways, 69.—Halpin, D., Valve-gear not affected by play of axle, 69.—Crompton, T. R., Tramway should be stronger than ordinary railroad, 69; arrangement of bearing springs, economy of fuel, size of wheels, 70; proportions of tubes, coning of wheels, 71.—Alley, S., Tramroads in general too light, 71; successful working of engines by one man, 71; failures of boilers in engines working in Paris, 72.—Adamson, D., Failure due to quality of water, 72; weakness of Brown boiler, working beam not so good as large wheels, 73.—Peacock, Richard, No injury from grease in boilers on Metropolitan Railway, 74.—Tomlinson, J., Quantity of grease very small on Metropolitan Railway, 74; cause of durability of fireboxes, 74.—Cochrane, C., Caustic soda removes corrosive action of greasy water,

LOCOMOTIVE, BROWN'S TRAMWAY (continued).

75.—Cowper, E.A., Action of acid grease cured by mixing hard water, 75; water in Paris produced greasy scale, 75.—Browne, B. C., No real objection to higher pressure, 76; mode of manufacture of Brown boiler, 76; protection of engine from dirt, 77; particulars of condenser, and results of working, 77; fuel consumption at Strasburg and Hamburg, 78; advantage of square link, 79; working of tramway engines by one man, 79; working of engines in Paris, 79; prospect of reducing cost of tramway engines, 80; present tramways far too light, 80; wheels in Brown engine not coned, 81; mixing of condensed steam with feed water, 81.

LOCOMOTIVE RUNNING SHED, *Paper* on the new Locomotive Running Shed of the Taff Vale Railway at Cathays, Cardiff, by C. H. Riches, 1884, 243.—Main shed, 243.—Engine pits, 244.—Workshops and offices, 244.—Drop pits, 245.—Yard, 245.—Sand drying, 246.—Water supply, 246.—Turntable, 246.—Traverser, 247.—Roof, 247.—Flange lubricator, 248.—Jet for washing rails, 249.—High-speed air-compressor, 249.

*Discussion.*—Haswell, J. A., Difficulty in getting engines out of shed, 249; advantage of turntables instead of traverser, 250; more ground occupied with turntables, 250.—Riches, T. H., Convenience for “day-in” engines, 250.—Wright, W. B., Comparative difficulty from breakdown of turntable and of traverser, 251; traverser should be at inner end of shed, 251.—Carbutt, E. H., Nature of Taff Vale traffic, 251.—Riches, T. H., Engines work out very rapidly, 252; relative risk of damage with traverser and with turntable, 252; details of Taff Vale traffic, 252.—Fearfield, J. P., Instance of accident with turntable, 253.—Tomlinson, J., Reason for design of shed, 253.—Bell, I. L., Locking up of engines or of money, 254.—Riches, C. H., Mode of getting engines in and out of shed, 254; turntables cost more than traverser, 255; objection to placing traverser at inner end of shed, 255; inconvenience for “day-in” engines, 255; convenience of repairing shop in running shed, 256.

Shed visited by Members, 157.

LOCOMOTIVE with Joy's Valve-Gear, 1880, 432-5, 440, 444, 448, 480.

LOCOMOTIVES, COMPOUND, *Paper* on the Compounding of Locomotive Engines, by A. Mallet, 1879, 328.—Compounding in locomotives seems specially advantageous, 328.—Steam-jacketing of doubtful use for locomotives, 328.—Special expansion gear causes complication and increased cost, 329.—Objections raised to compounding, 330.—Author first introduced compound system on Biarritz railway, 330.—Description of engines used for the Biarritz railway, 331.—Results of working, 333.—Engines for the Hainonville railway, and results of working, 334.—Self-acting reducing valve, 337.—Compounding of existing locomotives, 339.—Goods engine, Northern railway of Spain, 339.—Passenger engine, Orleans railway, 340.

## LOCOMOTIVES, COMPOUND (continued).

—Conclusions, 343.—Table of dimensions of compound locomotives, 346.

*Discussion.*—Mallet, A., Real position of the engine on the Orleans railway as to economy, 348; greater uniformity of power with compound engines, 349.—Tomlinson, J., Jun., In case of large locomotives, difficulties and expense increased by compound system, 349.—Webb, F. W., Has altered an engine to compound system with apparent success, 350; system should be tried on underground railways, 350.—Daniel, W., Experiments with compound semi-portable engine, 351.—Crampton, T. R., Nothing gained by grades of expansion higher than six, 353.—Webb, F. W., Effect on bearings of working with high expansion, 353.—Crampton, T. R., No difficulty in making even-going engines with not above six grades of expansion, 354.—Phillips, J., Not same amount of pressure in simple and in compound engine, 354.—Cowper, E. A., Same economy cannot be obtained with simple as with compound engine, 354; advantages of steam-jacketing, 354; cut-off in compound engine, 355; necessary to cut off at half stroke, 356; chief drawback to compounding locomotives is want of room, 356; no difficulty in compounding high-pressure engines in general, 357.—Crohn, F. W., "Continuous expansion" steam engines, 357.—Schönheyder, W., Compounding would relieve locomotives from severe stress during first half of stroke, 358; simple-cylinder engines cannot give same efficiency as compound, 358; utility of steam-jacket up to 150 revolutions, 359; cut-off in compound engine, 359; proper way of putting together indicator diagrams from the two cylinders, 360.—Kennedy, A. B. W., Ditto, 361.—Gray, J. M., Coal economy not important in locomotives, 362; high back-pressure prevents economy from expansion, 362.—Crampton, T. R., Jacketed locomotives satisfactory, 363.—Daniel, W., His engine not steam-jacketed, 363.—Robinson, J., Hopes trials will soon be made in England, 363.

LOCOMOTIVES, COMPOUND, *Paper on Compound Locomotive Engines*, by F. W. Webb, 1883, 438.—Experimental compound locomotive, 438.—Present compound locomotives, 439.—Valve-motion, 440.—Consumption of coal, 442.—Water-space of fire-box under the grate, 442.—Radial axle-box for leading axle, 443.—Long journals for axles, 444.—Steam brake, 444.—Leading dimensions of engine, 444.

*Discussion.*—Mallet, A., Mode of doing away with coupling-rods, 446; steadiness of compound locomotive, 446; early proposal of compound locomotive, 446.—Rich, W. E., Compound agricultural engines, 447; economy of compound locomotive, 447; water in low-pressure cylinder, 448; intermittent blast, 448; straightness of exhaust line in high-pressure diagrams, 448; advantage of steam-jacket, 449.—Gottschalk, A.,

## LOCOMOTIVES, COMPOUND (continued).

Compounding of locomotives for mountain lines, 449.—Crampton, T. R., Importance of simplicity, 450; economy mainly due to extra expansion, 450; advantage of doing away with coupling-rods, 450.—Borodin, A., Starting power of compound locomotive, 451; economy obtained higher than can be due to compounding alone, 452.—Webb, F. W., Economy partly arises from doing away with coupling-rods, 452.—Borodin, A., Probable adoption of compound principle, and of condensation in locomotives, 452.—Joy, D., Advantages of compound locomotive, 453; desirability of equalising power in the cylinders, 454; economy in consumption of water, 454; higher steam-pressure for compound locomotive, 454.—Morandiere, J., Early design for compound locomotive, 455.—Halpin, D., Advantage of radial axle-box, 455; importance of steam-jackets, 456; consumption of water in compound locomotive, 457; relative efficiency of non-condensing and condensing engines, 457.—McDonnell, A., Importance over-rated of doing away with coupling-rods, 458; number of cylinders is matter of convenience, 459.—Stroudley, W., Economy from compounding is established, 459; still better results from compounding goods engines, 459.—McDonnell, A., What kind of coal used, 460.—Crampton, T. R., What quantity of coal for lighting up and shunting, 460.—Webb, F. W., Cranks of high-pressure cylinders at right angles, 460; exhaust line of high-pressure cylinders at right angles, 460; exhaust line of high-pressure diagram, 460; mode of taking indicator diagrams, 460; Welsh coal used, 460; present running of compound locomotives, 460; comparative complication in engines, 461; quantity of fuel and water carried, 461; first performance of compound locomotive, 461; objection to coupling-rods for engines on very sharp curves, 462.

LOCOMOTIVES, COMPRESSED-AIR, for Tramways. *See* Compressed-Air Engines, 1881, 649.

LOCOMOTIVES, FIRELESS, *Paper* on Fireless Locomotives for Tramways, by L. Francq, 1879, 610.—Principle of fireless locomotive, 611.—Description of engine, 611.—Steam expander, 613.—Particulars of fireless locomotives, 616.—Stationary steam boilers, 617.—Results of working on French tramways, 618.—Economy of working as compared with other systems, 620.—Practical applications of the system, 622.—Reports of Austrian and French commissions, 623.—Application to other purposes, 624.—Application to railway locomotives of principle of expansion apart from the cylinders, 624.

*Discussion.*—Bergeron, C., Working of fireless locomotive on Marly tramway, 626; difficulty of heating whole mass of water in reservoir, 626.—Campbell, J., Difficulty of getting boiler steam incorporated with water in reservoir, 627.—Crampton, T. R., Economy to be effected by fireless locomotive, 627.—Ramsbottom, J., Simplicity and safety of fireless



## LOCOMOTIVES, FIRELESS (continued).

locomotive, 628; question of expansion apart from cylinders, 628; protection of engine motion from dirt, 628.—Tomlinson, J., Difficulties opposing application on Metropolitan railway, 629; method of condensing on Metropolitan railway, 630.—Webb, F. W., Protection of machinery &c. in Brown's tramway locomotive, 630; possibility of fireless engines on Underground railway, 631.—Crampton, T. R. Francq's engine not intended for long runs, 631.—Paget, A., Importance of low pressure at exhaust, 631.—Adamson, D., Saving in dead weight with fireless locomotive, 631; advantage with low pressure due only to particular arrangements, 632; larger surface desirable for superheating the steam, 632; causes of economy in fireless engine, 633.—Head, Jeremiah, Advantages resulting from saving of weight, 633; ditto from no blast being needed, 634.—Richardson, W., Stationary boilers advantageous for drawing gas from sewers, 634.—Welch, E. J. C., Waste of mechanical work in wire-drawing high-pressure steam, 634; high-pressure more economical than low-pressure steam, 635; Cowper's diagram of steam expansion not correct, 635; better to produce the whole expansion in cylinder, 635.—Cowper, E. A., Saving of weight in fireless locomotive, 635; loss of power by expansion of steam before admission to cylinder, 636; prevention of noise from exhaust steam, 637; applicability of fireless locomotive, 637.—Campbell, J., Time occupied in charging reservoir, 638; casing of reservoir and boilers, 638.—Bergeron, C., Circumstances prohibiting use of locomotives with fires, 638; retention of heat in reservoir of fireless engine, 639.—Robinson, J., Fireless locomotive easily adapted to give whole expansion in cylinders, 639; water not evaporated is not thrown away, 640; absence of blast-pipe admits of complete expansion, 640; engine motion might be placed above, 640; use of fireless engine upon light railways, 640.

*Reply* on the discussion upon Fireless Locomotives, by L. Francq, 1880, 37.—Chief items of working cost in tramway engines are wages and maintenance, 37.—Working parts of fireless engines are too near ground, but repairs insignificant through absence of ashes, 37.—Application of hot-water engine to underground railways, 38.—Condensation of steam on underground railways, and on tramways, 39.—Steam expander does not produce electricity, 40.—Advantage of expanding before admission into cylinders, 41.—Theoretical loss, but not important, 42.—Practical results with fireless engine, 43.

LOCOMOTIVES, Flange Lubricator, 1884, 248. Jet for washing rails, 1884, 249.

LOCOMOTIVES, FUEL CONSUMPTION, *Paper* on the Consumption of Fuel in Locomotives, by G. Marié, 1884, 82.—Modern advance in economy of fuel, 82.—Proper way of reckoning fuel consumption in locomotives,

## LOCOMOTIVES, FUEL CONSUMPTION (continued).

82.—Author's first experiments in 1877, 83.—Experiments repeated in 1882, 83.—Choice of line, 83.—Choice of train, 84.—Principal dimensions of engine, 84.—Calculation of work done, 85.—Consumption of fuel, 85.—Correction for difference of heat in boiler, 87.—Consumption of fuel per effective HP. per hour, 88.—Consumption of water and production of dry steam, 88.—Nature of fuel, 88.—Remarks, 89.—Further experiments, 89.—Conclusions, 90.—Experiments by M. Regray, 90.—Locomotives ought to have large heating surface and large cylinders, 91.—High piston-speed is favourable to economy in fuel, 91.—Consumption of fuel depends on skill of drivers, 91.—Tabular summary of experiments, 92–95.—Comparison of practical with theoretical results, 96.—Efficiency of boiler, 96.—Feed-water should be heated with exhaust steam, 96.—Efficiency of boiler and engine together, 96.—Efficiency of engine alone, 97.—Comparison with Corliss engine, 98.—Increased boiler pressure is necessary for further economy, 99.—Mr. Webb's compound locomotive, 99.—Ordinary valve-gear gives expansion enough with ordinary boiler-pressure, 99.—Paris and Lyons express engines, 100.—With higher pressures, either better valve-gear must be employed, or the compound system, 100.—Compound system will give better results with goods engines than with express, 101.

*Discussion.*—McDonnell, A., Care bestowed on author's experiments, 101; compound plan less simple in goods than in passenger engines, but promises better results, 102.—Ramsbottom, J., Locomotive boiler shows good results as a steam generator, 102; higher pressure necessary for compound system, 103.—Robinson, J., Author's object in improvement of locomotive is economy of fuel, either by increased pressure, or by use of compound engine, 103; economy in Mr. Webb's compound passenger engines, 104.—Tomlinson, J., Economy by higher pressure may be bought too dear, 105; high piston-speed is the secret of success in compound engines, 105; compound engine would fail for short runs, 105; economy of 25 per cent. not possible from compounding, except in condensing engines, 105; advantage of doing away with coupling-rods, 106; shorter duration of boilers and of gland packings with higher pressure, 106.—Halpin, D., Experiments on Bavarian State Railways, 106; recent improvements in indicators, 107; Crosby indicator, and Boys power meter, 107; complete indicating tackle used by M. Regray, 107; net power available for traction, 108; efficiency of various types of boilers, 108; comparative table, 109; superiority of locomotive boilers both in rapidity and in economy of evaporation, 110; beneficial effects of tremor in running, 110; economy of fuel and of repairs is not the sole object to be aimed at, 111; relation of power to weight of locomotives, 111; recent

## LOCOMOTIVES, FUEL CONSUMPTION (continued).

performances of compound locomotive, 112; saving of water as well as of coal by use of exhaust-steam injectors, 113; steadiness of boiler pressure in working of compound locomotive, 113.—Longridge, M., Economical results of compounding are due chiefly to increase in pressure and in grade of expansion, 114; limit now very nearly attained of economy from increase of pressure, 114.—Rich, W. E., Comparative results from locomotive and portable engines, 115.—Aspinall, J. A. F., Satisfactory results from compound locomotives, 115.—Banderali, D., Importance of Mr. Webb's experiments, 116.—Robinson, J., Compound locomotive now being made for Western Railway of France, 116.—Paget, A., Mr. Webb should be asked to reply to remarks about compound locomotives, 116.—Tomlinson, J., Nursing of improvements, 116.—McDonnell, A., Experimental results are better than average, 117.—Tomlinson, J., Difference between best and average drivers, 117.—Cowper, C. E., Duration of trials, 118; meaning of indicated horse-power, 118.—Bell, I. L., Duty of driver to nurse his engine, 118; experimental results always better than in regular work, 118; evils of insufficient or excessive admission of air to fire, 119; importance of chemical part of subject, 119.—Webb, F. W., Average coal consumption and mileage of compound locomotives, 119; trial of compounded side-tank engine on Madeley incline, 120; particulars of trip with Scotch express, 120.—Marié, G., Increased pressure and improved mechanism are both necessary for economy, 121; ordinary locomotives not suitable for high pressure and great expansion, 121; recent improvements in indicators, 121; friction of pistons and valve-gear, 122; priming, 122; comparison of author's experiments with those on compound locomotive, 122; trial of express locomotive on Paris and Lyons railway, 122; weight of tender should be included with train, 123; advantage of large cylinders and large heating surface, 124; compound locomotive with higher expansion is suitable for higher pressure, 124; steam-jacket unnecessary for locomotives, 124; measurement of entire fuel consumption precludes error from short duration of trial, 124; anticipated superiority of compound locomotives with higher pressures, 125.

LOCOMOTIVES, Petroleum Refuse as Fuel in Locomotives, 1884, 272. *See* Petroleum Fuel in Locomotives.

LOCOMOTIVES UPON TRAMWAYS. *See* Tramways, Mechanical Traction, 1878, 409.—Compressed Air, 1881, 649.—Locomotives, Fireless, 1879, 610.

LOCOMOTIVE WORKS, visited at Glasgow meeting; North British Railway, 1879, 569.—Neilson and Co., 570.—Caledonian Railway, 570.—Dübs and Co., 571.

LOGAN, A. L., elected Member, 1884, 1.

LOGAN, R. P. T., elected Member, 1883, 309.

LOGAN, W., elected Member, 1874, 55.

LONDON MEETINGS OF INSTITUTION, Alteration of Rules, 1874, 28, 29, 30, 31, 32.

LONGBOTTOM, L., elected Member, 1884, 408.

LONGRIDGE, M., elected Member, 1880, 310.

Locomotives, Fuel Consumption, 1884, 114.

Engine Recorder, *Paper* on the Moscrop Engine Recorder, and the Knowles Supplementary Governor, 1884, 150.—Remarks, 163.

LONGRIDGE, R. C., elected Member, 1875, 314.

Riveted Joints, 1881, 266, 267, 268.

LONGRIDGE, W. S., memoir, 1879, 11.

LONGWORTH, D., elected Member, 1880, 185.

Cutting of Metals, 1883, 256.

Hammers, *Paper* on Power Hammers with Movable Fulcrum, 1882, 204.  
—Remarks, 212.

LONTIN MACHINE for electric lighting, 1878, 530, 543. *See* Electric Lighting.

LORD, E., decease, 1876, 3.—Memoir, 22.

LORD, W., elected Member, 1882, 475.

LOSADA, Capt., Traction Engines in India, 1879, 520.

LOWCOCK, A., elected Member, 1884, 408.

LOWDON, J., elected Member, 1884, 80.

LOWE, S. H., elected Member, 1883, 179.

LOWOOD, J. G., elected Associate, 1881, 409.

LOWTHIAN, G., elected Graduate, 1879, 398.

LOYELBACH FACTORIES, transmission of power by wire ropes, 1874, 57.

LUFTON, A., elected Member, 1877, 72.

Mining Machinery, 1882, 370.

LÜTHY, R., elected Member, 1878, 31.—Memoir, 1884, 403.

Gauge, Standard Gauge for High Pressures, 1880, 473.

LYE CROSS COLLIERY, 1876, 332.

LYNDE, J. G., decease, 1884, 3.—Memoir, 66.

Compressed-Air Engines for Tramways, 1881, 676.

Tramways, Permanent Way, 1880, 203, 221.

LYNDE, J. H., elected Member, 1878, 107.

## M.

MACBETH, N., elected Member, 1883, 593.

MACCARTHY, S., elected Member, 1884, 408.

MACCOLL, H., elected Member, 1877, 26.

MACDONALD, A. V., elected Member, 1879, 398.

MACDONALD, R. M., elected Graduate, 1881, 10.

MACFARLANE, W., Vote of thanks, Reply to, 1879, 565.

Water-Pressure Regulators, 1879, 438, 439.

MACHINERY FOR CULTIVATING LAND by Horse-power, 1880, 529. *See* Cultivation by Horses.

MACHINERY FOR PREPARING AND SPINNING COTTON, 1880, 492. *See* Cotton Spinning Machinery.

MACHINES for producing Cold Air, 1881, 105-132. *See* Cold Air.

MACILRAITH, J., elected Associate, 1883, 34.

MACKAY, J., decease, 1874, 2.—Memoir, 22.

MACKENZIE, T. B., elected Graduate, 1883, 591.

MACKINTOSH, A. R., elected Member, 1884, 199.

MACKISSON'S permanent way for Tramways, 1880, 199. *See* Tramways, Permanent Way.

MACLAGAN, R., elected Member, 1875, 189.

MACLELLAN, J. A., elected Member, 1877, 165.

MACNAY, W., decease, 1883, 36.—Memoir, 19.

MACPHERSON, A. S., elected Member, 1884, 80.

MADGE, H. J., elected Member, 1878, 293.

MAGINNIS, J. P., elected Member, 1879, 155.

MAGNETIC CHUCK, 1875, 38. *See* Chuck, Electro-Magnetic.

MAGNET, CURRIE LONG-PULL, 1884, 445. *See* Railway Electric Signals.

MAIR, J. G., Iron and Steel, Physical condition of, 1884, 59.

Power Transmission, 1881, 97.

Water-Pressure Regulators, 1879, 437.

MAIS, H. C., elected Member, 1884, 409.

MALAN, E. de M., elected Graduate, 1883, 34.

MALCOLM, B., elected Member, 1879, 398.

MALLET, A., Locomotives, Compound, *Paper* on the Compounding of Locomotive Engines, 1879, 328.—Remarks, 348.

Locomotives, Compound, 1883, 446.

Tramways, *Paper* on Mechanical Traction upon Tramways, 1878, 395.—Remarks, 437.

MALLORY, G. B., elected Member, 1881, 624.

MAÑÉ, M., elected Member, 1882, 255.

MANLOVE, W. M., elected Member, 1876, 197.

MANNING, J., Mayor of Nottingham, Welcome to Members at Nottingham meeting, 1884, 407.

MANNING, J., decease, 1875, 3.—Memoir, 29.

MANNOCK, T., elected Graduate, 1878, 108.

MANSERGH, J., elected Member, 1875, 65.

MAPPIN, W. S., elected Member, 1882, 16.



MARIE, G., elected Member, 1878, 558.

Brakes, *Paper* on recent Brake experiments upon the Lyons railway, 1879, 157.—Remarks, 196, 202, 213, 217.

Gauge, *Paper* on a Standard Gauge for High Pressures, 1880, 455.—Remarks, 475.

Locomotives, *Paper* on the Consumption of Fuel in Locomotives, 1884, 82.—Remarks, 121.

MARIEMONT AND BASCOUP COLLIERIES, visited at Summer meeting, Belgium, 1883, 517.—Description, 570.

MARIHAYE COLLIERIES, visited at Summer meeting, Belgium, 1883, 513, 530.

MARINDIN, F. A., Brakes, Effect of, upon railway trains, 1878, 630.

MARINE BOILER CORROSION, 1884, 331; Admiralty practice, 351. *See* Boiler Corrosion.

MARINE ENGINE, *Paper* on the Progress and Development of the Marine Engine, by F. C. Marshall, 1881, 449.—Former paper by Sir Frederick Bramwell, 449.—Subsequent progress realised, 450.—Table of particulars and fuel consumption of compound marine engines, 452.—Compound two-cylinder vertical engine, with receiver, 450.—Single Woolf or tandem engine, with single crank and fly-wheel, 453.—Double and triple tandem engines, 453.—Three-cylinder Woolf engine, 453.—Three-cylinder intermediate-receiver compound engine, 454.—Three principal types of compound engine, 455.—Marine boiler, single-ended and double-ended, 455.—Holt's double-ended boiler, 456.—Navy boiler, 457.—Thornycroft's boiler, locomotive type, 457.—Perkins' boiler, 458.—Steel boilers, 458.—Corrosion of boilers, 459.—Superheating of steam, 460.—Present demand for largely increased power, 460.—Weight of machinery, water, and fuel, 460.—Consumption of fuel, 463.—Letter of Mr. Alfred Holt, 463.—Efficiency and safety, 465.—Locomotive boiler with forced draught, 469.—Economy from higher pressures of steam, 471.—Losses with high pressure, 472.—Surface condenser, 474.—Air and circulating pumps, 474.—Use of steel for shafts, 475.—Steel castings, crank-shafts, and propeller-blades, 476.—Screw propellers, 476.—Summary of progress, 477.

*Discussion.*—Marshall, F. C., Saving in fuel greater from inferior coal now used, 479.—Kirk, A. C., Steam pressure and expansion quite high enough in present engines, 479; coal economy has not kept pace with increased weight and cost of engines, 480; distinction between Woolf engine and receiver engine, 480; multiplication of engines, 481; reduction in weight of engines, 481; origin of three-cylinder compound engine, 482; boilers, marine and locomotive type, 482; circulation of water in condensers, 483; steel castings, and testing of cast-steel pistons, 483; size of screw-propeller, 483.—Crow, G., Handling of single-crank tandem engines, 484; relative economy of Woolf and receiver engine, 484.—

## MARINE ENGINE (continued).

Rogerson, J., Economical results from Perkins boiler, 485: soundness of steel castings, 486.—Bramwell, Sir F. J., Mode of ascertaining indicated horse-power, 486; result of trial of Perkins engines, 486; construction of surface condenser, 487; use of forced draught with anthracite coal, 487.—Parker, W., Reduction in fuel consumption must become slower, 487; pressures in present marine boilers, 488; boiler shells in solid rings, 488; difference between Board of Trade and Lloyd's rules for strength of boilers, 488; two screws better for large steamers, 489.—Rich, W. E., Tables should give weight of steam used, 490; use of Froude's marine dynamometer for the screw-propeller, 490; improved valve-gear and valves, 491; reduction of condensing surface, 491.—Nichol, B. G., Three views as to future of the marine engine, 491; advantages of single engine, 492; economical results of compound engines, 492; improvement by forced draught, 492; means of checking coal consumption and supply, 493.—Fox, S., Corrugated flues, number made, evaporative power, and mode of manufacture, 493.—Head, Jeremiah, Higher boiler pressure calls for higher temperature in firebox, 495; loss of heat through nitrogen, 496; strength of boiler as affected by plates breaking joint, 496; factor of safety should be determined by elastic limit, 497.—Crampton, T. R., Economy of boiler and engine should be separated, 497; advantages of single engine, 498; circulation of condensing water by pressure or by suction, 498; advantages of self-acting firing, and use of dust-fuel, 498.—Reynolds, E., Irregular power from single engine, 499; comparison of locomotive type of boiler for locomotive and marine purposes, 500; necessity for sufficient area of water surface, 501.—Adamson, D., Selection of best type of marine engine, 501; percussive action of single engine, 502; advantages of quadruple engine, 502; riveted joints, and use of corrugated flues, 504.—Marshall, F. C., Practical limit of steam pressure, 504; dead-weight capacity and measurement capacity, 505; light engines might be best, though necessarily costly, 505; locomotive type of boiler, 506; difference of coal consumption in Woolf and receiver engines, 507; accuracy of tabulated results, 507; results of Perkins boiler and engine, 508; restrictions by Board of Trade and by Lloyd's, 508; corrugated flues, 508; importance of coal consumption in marine engines, 509.

MARINE-ENGINE DYNAMOMETER, 1877, 237. *See* Dynamometer, Marine-Engine.

MARINE ENGINEERING, North-East Coast Exhibition, 1882, 472. *See* Exhibition.

MARINE GOVERNOR, Pneumatic, 1879, 406.—“Velometer,” 410. *See* Governor, Marine.

MARINE HYDRAULIC MACHINERY, 1874, 33. *See* Hydraulic Machinery, Marine.

MARKHAM, C., Dock, Victoria Floating, 1878, 180.

Engines, Pumping, Direct-Acting, 1874, 274, 277.

## MARKHAM, C. (continued).

Expansion Gear, Correy, 1878, 524.

Railway Traffic, Cost of, 1878, 203, 212.

Secretary, appointment, 1884, 77, 78.

Tramways, Mechanical Traction, 1878, 428, 434.

MARQUAND, A. J., elected Member, 1884, 80.

MARRACK, P., elected Graduate, 1883, 34.

MARSHALL, A., elected Member, 1875, 189.

MARSHALL, F. C., elected Member of Council, 1882, 32.

Boiler Corrosion, Marine, 1884, 344.

Marine Engine, *Paper* on the Progress and Development of the Marine Engine, 1881, 449.—Remarks, 479, 504.

Petroleum Fuel in Locomotives, 1884, 308.

Steam-ship "City of Rome," 1880, 349, 356.

Valve-Gear, Joy's, 1880, 430, 446.

MARSHALL, W. B., elected Member, 1877, 72.

MARSHALL, W. E., decease, 1881, 11.—Memoir, 5.

MARSHALL, W. P., Watt, Inventions of James Watt, 1883, 626.

MARTELL, B., Ships, Iron and Steel for, 1881, 561.

MARTEN, E. B., Accidents, Mine, *Paper* on Special Mechanical Appliances for meeting the requirements of certain classes of Mine Accidents, by C. Hawksley and E. B. Marten, 1877, 314.

Boiler and Engine, High-Pressure, 1877, 130.

Boiler Feeder, Fromentin Automatic, 1882, 490.

Diving Appliances, 1882, 195.

Engines, Pumping, Direct-Acting, 1874, 274.

Iron and Steel for Boilers, 1879, 317.

Tynewydd Colliery Inundation, 1877, 229.

Valves, Safety, 1877, 193.

Water Meters, 1882, 86.

Watt, Inventions of James Watt, 1883, 628.

MARTIN, E. P., elected Member, 1881, 163.

MARTIN, H., elected Member, 1878, 107.

MARTIN, R. F., elected Member, 1880, 185.

MARTINDALE, W. B. H., elected Graduate, 1882, 255.

MARTLEY, W., decease, 1875, 3.—Memoir, 29.

MASEFIELD, R., elected Member, 1882, 255.

MASON SCIENCE COLLEGE, visited at Autumn meeting, Birmingham, 1883, 597, 598.

MASSEY, G., elected Member, 1884, 409.

MASSICKS, T., elected Member, 1880, 489.

MATHER, J., elected Member, 1876, 197.

- MATHER, W., Steel, Fluid-Compressed, and Guns, 1875, 292.
- MATHER, W. P., elected Member, 1883, 179.
- MATHESON, H. C., elected Member, 1882, 475.
- MATTHEWS, J., elected Member, 1875, 189.
- MATTHEWS, T. W., elected Member, 1875, 189.
- MATTOS, A. G. DE, elected Member, 1875, 35.
- MAW, M. H., elected Graduate, 1882, 16.
- MAW, W. H., Docks, Pumping Machinery, 1874, 160.  
     Dynamometers, 1876, 236.  
     Expansion Gear, Automatic, 1882, 432.  
     Gas Engine, Atmospheric, 1875, 205.  
     Gauge, Standard, for High Pressures, 1880, 473.
- MAXIM, H. S., elected Member, 1884, 409.
- MAY, R. C., decease, 1883, 36.—Memoir, 20.
- MAY, W., elected Member of Council, 1875, 34.—Decease, 1878, 21.—Memoir, 12.
- MAYHEW'S Automatic Boiler Feeder, shown at Cardiff meeting, 1884, 357.
- MCCARTER CONDENSER, 1876, 299. *See* Condenser, McCarter.
- MCCLEAN, F., elected Member, 1874, 55.
- MCCLEAN, J. R., decease, 1874, 2.—Memoir, 23.
- MCCONNOCHIE, J., Docks, Cardiff, *Paper* on the Bute Docks, Cardiff, and the Mechanical Appliances for shipping Coal, 1874, 119.—Remarks, 143.—  
*Paper* on recent extensions of Dock Accommodation and Coal-Shipping Machinery at the Bute Docks, Cardiff, 1884, 227.—Remarks, 239, 241.
- MCDONALD, J. A., elected Graduate, 1878, 108.
- MCDONNELL, A., Brakes, Automatic Action in, 1880, 134.  
     Brakes, Effect of, upon railway trains, 1878, 627.  
     Forging of Crank Shafts, 1879, 477.  
     Locomotives, Compound, 1883, 458, 460.  
     Locomotives, Fuel Consumption, 1884, 101, 117.
- MCGREGOR, J., elected Member, 1881, 624.
- McKAY, J., elected Member, 1881, 163.
- McKAY'S HYDRAULIC EQUILIBRIUM DRILL, 1878, 569.
- McKEAN'S PERCUSSIVE DRILL, 1875, 111.
- McLACHLAN, J., elected Member, 1880, 310.
- McLAREN, R. L., elected Graduate, 1882, 146.
- McLEAN, W. L. E., elected Member, 1879, 583.  
     Forging of Crank Shafts, *Paper* on the Forging of Crank Shafts, 1879, 461.—Remarks, 479.
- McONIE, W., Jun., elected Member, 1884, 2.
- MEATS, J. T., elected Member, 1882, 145.
- MECHANICAL APPLIANCES FOR MINE ACCIDENTS, 1877, 314. *See* Accidents, Mine.
- MECHANICAL FIRE FEEDER, 1876, 318. *See* Fire Feeder, Mechanical.

- MECHANICAL PUDDLING, 1876, 244. *See* Puddling, Mechanical.
- MECHANICAL RESEARCH. *See* Research.
- MECHANICAL TRACTION UPON TRAMWAYS, 1878, 395. *See* Tramways, Mechanical Traction.
- MECHANICAL VENTILATORS. *See* Ventilators, Mechanical, for Mines, 1875, 217.—Ventilator, Roots' Mine, 1877, 92.
- MEDWAY RIVER, approach to Chatham dockyard. *See* Docks, Pumping Machinery, 1874, 145.
- MEETINGS, ATTENDANCES AT, 1874, 28.—1875, 6.—1876, 6.—1877, 6.—1878, 23.—1879, 26.—1880, 14.—1881, 14.—1882, 21.—1883, 40.—1884, 7.
- MEIK, C. S., elected Member, 1881, 624.
- MÉKARSKI'S system of working tramways. *See* Tramways, Mechanical Traction, 1878, 395.
- MÉLEN, E., Wool-Washing Works, visited at Summer meeting, Belgium, 1883, 515.—Note on Works, 547.
- MELIN, A., Sugar, *Paper* on the Manufacture of Sugar in Belgium, 1883, 368.
- MELROSE, J., elected Member, 1883, 33.
- MEMOIRS of Members deceased, 1874, 16.—1875, 19.—1876, 17.—1877, 16.—1878, 9.—1879, 9.—1880, 1.—1881, 1.—1882, 1.—1883, 1.—1884, 61, 398, 472.
- MENELAUS, W., elected Vice-President, 1874, 26.—1875, 34.—1876, 26.—1877, 25.—Member of Council, 1878, 29.—1880, 24.—Decease, 1882, 253; 1883, 36.—Memoir, 1883, 20.  
Address of President, 1880, 322.  
Engines, Pumping, Direct-Acting, 1874, 272.  
Hydraulic Machinery, Toulon, 1878, 390.  
Rules, 1878, 39.
- MENIER CHOCOLATE WORKS at Noisiel, visit to, 1878, 550.
- MENIER, H., elected Member, 1878, 558.
- MENZIES, W., elected Member, 1876, 197.
- MERRYWEATHER, H., elected Member, 1877, 72.—Decease, 1882, 17.—Memoir, 9.
- MERRYWEATHER, J. C., elected Member, 1875, 189.
- MERRYWEATHER, R. M., decease, 1878, 21.—Memoir, 13.
- MERRYWEATHER'S tramway locomotive, 1878, 411, 415, 416, 420. *See* Tramways, Mechanical Traction.
- MERTHYR SEWAGE FARM, downward intermittent filtration areas, and wide irrigation land, 1874, 237.
- MERTHYR VALE COLLIERY, Messrs. Nixon's, pit-head gear and winding engines, 1874, 236.
- MESSENT, P. J., Tyne Improvements, Description of, 1881, 612.
- METALS, Cutting of, 1883, 226. *See* Cutting of Metals.
- METERS for registering Small Flows of Water, 1882, 41. *See* Water Meters.



METER, WATER, Barton and West's, 1879, 444. *See* Water Meter.

METERS, Testing, 1884, 190. *See* Testing Current-Meters.

MEYSEY-THOMPSON, A. H., elected Member, 1881, 163.

Engineering in Leeds, *Paper* on the History of Engineering in Leeds, 1882, 266.

MICHELE, V. D. DE, elected Member, 1877, 165.

MIDDLETON, R. E., elected Member, 1884, 199.

MIERS' plan of movable cofferdam, for removing screw-propellers, 1878, 179.

MILBURN, J., elected Member, 1874, 101.

MILLAR, W. J., Reply to vote of thanks, 1879, 565.

MILLES, R. S., elected Graduate, 1881, 164.

MILLOM BLAST FURNACES, visited at Barrow meeting, 1880, 486.

MILWARD'S NEEDLE WORKS, Redditch, 1876, 341.

M.I.M.E., use of initials, 1880, 311.

MINE ACCIDENTS, 1877, 314. *See* Accidents, Mine. *See* Tynewydd Colliery Inundation, 1877, 221.

MINE PUMPING ENGINES. *See* Engines, Pumping, Direct-Acting, 1874, 258.

MINERAL WAGONS, SOUTH-WALES, 1884, 415. *See* South-Wales Mineral Wagons.

MINES. Prevention of explosions, 1879, 237. Influence of coal dust, 229, 230, 231, 235, 236. Electric lighting of mines, 229, 232, 236. *See* Safety Lamps.

MINES, *Paper* on the Hæmatite Iron Mines of the Furness district, by J. L. Shaw. 1880, 363.—Geological features, 363.—Extent of ore deposits, 364.—Depth of deposits below surface, 365.—Quality of ore, 365.—Modes of working, 365.—Timbering, 367.—Output, 368.—Trial borings, 368.—Winding and pumping engines, 368.—Adits, 369.

*Discussion*.—Wadham, E., Uncertainty of hæmatite deposits, and consequent irregular method of working, 369; subsidence of surface over workings, 370; sinking of main shaft, 370; timbering, 371.—Cowper, E. A., Hæmatite ore not magnetic, 371.—Wadham, E., North and south direction of Furness mineral veins, 371.—Cochrane, C., Whether search made for iron ore beneath Yoredale shales, 372.—Wadham, E., Ore found beneath Yoredale shales at Stank, 372.—Schneider, H. W., Uncertainty of iron ore deposits, and discovery of Stank mine, 372; Park mine and neighbouring deposits, 373.—Adamson, D., Geological conditions of district, 374; analogies from other districts, 375; probable position of iron ore deposits, 376.—Shaw, J. L., Prevalence of iron in all rocks, 376.

Schneider, H. W., Rise and progress of Barrow, and development of iron mining in Furness district, 377-9.

MINES, Hæmatite Mines visited at Barrow meeting, 1880, 484-7.

MINES, Electricity for working Coal Mines, 1883, 421. *See* Electricity for Coal Mines.

**MINES, MECHANICAL VENTILATORS FOR.** *See Ventilators for Mines, Mechanical*, 1875, 317.—Ventilator, Roots' Mine, 1877, 92.

**MINING ENGINES, Water-Pressure**, 1880, 245. *See Water-Pressure Engines*.

**MINING MACHINERY**, *Paper on Mining Machinery*, by H. Davey, 1882, 319.—Shaft-sinking, 319; percussive boring tools, 319; diamond drill, 320; Kind-Chaudron system, 322.—Pumping, 323; methods of pumping during sinking, 325; trip-gear for limiting speed of engine, 326.—Winding, 327; cam gear for expansion and reversing, 327; improvements in direct-acting winding engines, 327; high speed of direct winding, 327.—Underground pumping, 328; experience in deep mines of Comstock lode, Nevada, 328; hydraulic pumping engines underground, 329.—Underground hauling, 330; comparative efficiency of air and water engines, 331.—Ventilation, 331; efficiencies of mechanical ventilators, 332; duty of furnaces, 333.—Economical application of power, 331, 334.

*Appendix on Shaft-Sinking in the Westphalian district*, by W. T. and T. R. Mulvany, 335.—Chalk formation of Westphalia, 336.—Shaft-sinking on old German system, 339.—Ditto on Kind-Chaudron system, 340.—Hibernia colliery, 340.—Shamrock colliery, 341.—Erin colliery, 342.—Hansa colliery, 346.—Zollern colliery, 351.—General remarks and deductions, 355.—Advantage of sinking two shafts together, 356.—Causes of difficulties in sinking, 357.—Advantages of tubbing, 358.—Comparison with Kind-Chaudron process, 359.—Further improvements in pumping desirable, 362.—Rate of sinking shafts, 362.—Cost, 363.—Channel tunnel, 363.

*Discussion.*—Davey, H., Heavily watered mines in Westphalian coalfield, 364; advantage of special pumping shaft to bottom of water-bearing strata, 365.—Greig, D., Kind-Chaudron process at Whitburn, 365; compressed-air preferable to water-pressure for underground engines, 366; objection to very large winding engines, 366.—Cowper, E. A., Advantage of trip gear for checking speed, 367; good arrangement of bell-cranks, 367.—Walker, B., Condensers worked by separate engines, 367; efficiency and advantages of compressed air, 367; travelling crane worked by air, 368; utility of fly-wheels, 369.—Lawrence, H., Mode of preventing choking of bore-hole while sinking large pit, 369; adoption of Chaudron process at Whitburn, 370; advantage of large winding engines for deep shafts, 370.—Lupton, A., Quantity of minerals raised in Great Britain, 370; sinking of shafts in metal mines and in coal mines, 370; methods of boring, 371; rough average for cost of boring, 371; Kind-Chaudron process, 372; objection to sinking bore-holes in advance of shaft, 372; useful effect from compressed air, 373; disadvantage of hydraulic hauling machinery, 373; means of transmitting power underground, 374; Koepe system of winding by short rope, 374; caloric engines, 374.—Head, J., Ventilation by pressure instead of by exhaustion,

## MINING MACHINERY (continued).

374.—Hall, W. S., Conical drum or tail ropes for counterbalancing in winding, 375; taper ropes for great depths, 376; winding at Sandwell Park colliery, 376; particulars of winding gear, 377; light steel cages for quick winding, 377; Fowler's system for loading and unloading cages, 377; best pressure for compressed air, correction of mistranslation, 378.—Smith, M. H., Suggestion for absorption of fire-damp, 379.—Browne, B. C., Underground locomotives, 380.—Davey, H., Kind-Chaudron process only good where pumping is impossible, 380; compressed-air engines less efficient than hydraulic, 380; trip-gear designed especially for compound engines, 381; prevention of choking up of bore-hole, 381; preliminary boring of small pumping pit, 382; failure of fly-wheels on heavy pumping engines, 383.

MOFFAT, T., elected Member, 1879, 398.

MOLESWORTH, G. L., elected Member, 1879, 398.

MOLESWORTH, J. M., elected Member, 1882, 16.

MOLINOS, L., elected Member, 1881, 409.

MONCRIEFF, W. D. SCOTT-, Compressed-Air Engines for Tramways, 1881, 649.

*See* Scott-Moncrieff.

MONROE, R., elected Member, 1884, 80.

MONT CENIS TUNNEL, rock-drilling machine, 1874, 99.

MOORE, B. T., elected Member, 1884, 2.

MOORE, J., elected Member, 1876, 57.

MOORE, R. ST. G., elected Member, 1882, 255.

MOORE, S., decease, 1875, 3.

MORANDIERE, J., Locomotives, Compound, 1883, 455.

MORDEY CARNEY AND CO.'S SHIPBUILDING WORKS AND DRY DOCKS, Newport, 1884, 394.

MORELAND, R., JUN., elected Member, 1880, 186.

MORFA COPPER WORKS, Landore, calcining, smelting, and refining furnaces, and rolling mill, 1874, 244.

MORGAN, J. L., decease, 1876, 3.—Mémorial, 23.

MORGANS, T., Expansion, Variable Automatic, 1877, 291.

Rock-Drilling Machinery, 1877, 217.

Tynewydd Colliery Inundation, 1877, 230.

MORIN, GENERAL A. J., decease, 1881, 11.—Mémorial, 5.

Brakes, Effect of, upon railway trains, 1878, 479.

Friction at High Velocities, *Letter* on, 1883, 666.

MORRIS, E. R., elected Member, 1880, 9.

MORRIS, E. L., elected Member, 1874, 256.

MORRISON, H. M., Power Transmission by Ropes, *Paper* on the Transmission of Water Power by Turbines and Wire Ropes, 1874, 56.—Remarks, 73.

- MOSCROP ENGINE RECORDER, 1884, 150. *See* Engine Recorder.
- MOSCROP, J. B., Engine Recorder, 1884, 160.
- MOTTARD, M., Mayor of Liège, Welcome to Members at Belgian meeting, 1883, 307.
- MOUNTSTUART SHIPBUILDING, GRAVING DOCKS, AND ENGINEERING WORKS, Cardiff, 1884, 238, 363.
- MOWER, G. A., elected Member, 1884, 199.
- MOWING MACHINES. *See* Harvesting Machinery.
- MUESELER SAFETY LAMP, 1879, 222. *See* Safety Lamps.
- MUIRHEAD, R., elected Member, 1876, 347.  
Traction Engines in India, 1879, 515.
- MULVANY, W. T. and T. R., On Shaft-Sinking in the Westphalian district (appendix to paper on Mining Machinery), 1882, 335. *See* Mining Machinery.
- MUNDELLA, A. J., Patent Laws, 1876, 192, 195.
- MURRAY, T. H., decease, 1879, 22.—Memoir, 12.
- MUSGRAVE, J., elected Member, 1881, 164.  
Rope Gearing, 1876, 391, 398.
- MUSGRAVE, W. M., elected Member, 1882, 475.
- MWYNDY IRON ORE MINE, Llantrissant, 1874, 247.

## N.

- NAISH, W. P., elected Member, 1876, 28.
- NAPIER, J., elected Vice-President, 1874, 26.
- NAPIER, J. M., Patent Laws, 1875, 180.
- NAPIER, R., decease, 1877, 3.—Memoir, 20.—Bequest of £100 applied to Library, 1880, 186.
- NEATE, P. J., elected Member, 1883, 309.
- NEEDLE WORKS, Redditch, 1876, 341.
- NELSON, J., elected Member, 1884, 199.
- NESFIELD, A., elected Member, 1881, 624.
- NETTLEFOLD, H., elected Graduate, 1882, 146.
- NETTLEFOLD, J. H., decease, 1882, 17.—Memoir, 9.
- NETTLEFOLDS' SCREW WORKS, Smethwick, 1876, 327.
- NEVILLE, R., elected Member, 1879, 398.
- NEWALL, J. W., elected Graduate, 1878, 108.
- NEWALL, R. S., elected Member, 1879, 33.
- NEWBURN STEEL WORKS, visited at Newcastle meeting, 1881, 607.
- NEWCASTLE DAILY CHRONICLE OFFICE, visited at Newcastle meeting, 1881, 609.

- NEWCASTLE MEETING, Announcement, 1881, 32, 165.—Meeting, 407.—Reception 407.—Business, 408.—Votes of thanks, 412.—Excursions &c., 595.
- NEWMAN, F., elected Member, 1881, 409.  
Filter, Farquhar, 1881, 157, 158.  
Water Meters, 1882, 75.
- NEWPORT WORKS, visited at Summer meeting, Cardiff, 1884, 359, 392.
- NEWSPAPER PRINTING MACHINE. *See* Printing Machinery, 1881, 511.
- NEWTON, W. E., decease, 1880, 10.—Memoir, 8.  
Chuck, Electro-Magnetic, *Paper* on Jaques Oakley and Sterne's Electro-Magnetic Chuck for holding special work in lathes &c., 1875, 38.  
Docks, Cardiff, 1874, 134.  
Patent Laws, 1875, 174, 184.—1876, 183.  
Puddling, Mechanical, 1876, 261.
- NEWTON, W. M., elected Member, 1876, 347.
- NICHOL, B. G., elected Member, 1881, 164.  
Coke Manufacture, 1883, 295.  
Marine Engine, 1881, 491.
- NICHOLL, E. M., elected Member, 1882, 475.
- NICHOLLS, J. M., elected Member, 1884, 199.
- NICHOLSON, H., elected Member, 1884, 80.
- NICHOLSON, T. H., elected Member, 1884, 199.
- NICHOLSON, W. E., elected Member, 1884, 80.
- NICOLSON, D., elected Member, 1877, 72.
- NIXON'S NAVIGATION COLLIERY, Aberdare Valley, winding engines with conical drums, 1874, 235.
- NOAKES, W. M., elected Member, 1884, 409.
- NOBLE, S. W. A., elected Graduate, 1882, 255.
- NORDENFELT, T., elected Member, 1882, 255.
- NORRIS, M. O., elected Graduate, 1881, 409.
- NORRIS, R. S., decease, 1879, 22.—Memoir, 12.
- NORTH, G., elected Member, 1883, 179.
- NORTH, J. T., elected Member, 1882, 475.
- NORTHCOTT, W. H., elected Member, 1878, 293.
- NORTH-EAST COAST EXHIBITION OF MARINE ENGINEERING &c., 1882, 472. *See* Exhibition.
- NORTH LONSDALE BLAST FURNACES, visited at Barrow meeting, 1880, 484.
- NOTTINGHAM AUTUMN MEETING, 1884, 407.—Reception, 407.—Business, 408.—Votes of thanks, 413.—Visits to works, 414.
- NUNNELEY, T., elected Member, 1882, 146.
- NURSEY, P. F., Petroleum Fuel in Locomotives, 1884, 312.  
Printing Machinery, 1881, 523.  
Silver Ore Amalgamation, 1884, 269.
- NYE, J. H., decease, 1877, 3.—Memoir, 21.



## O.

- OBSERVATORY, PARIS, visit to, 1878, 546.
- O'CONNOR, J. F., elected Graduate, 1883, 310.
- OFFICERS. *See* Council, Members of.
- OGI PAPER MILL, Japan. *See* Paper Mill, Ogi, 1876, 127.
- OKES, J. C. R., elected Member, 1875, 35.
- OLDHAM, R. A., elected Member, 1880, 310.
- OLRICK, H., elected Member, 1882, 475.  
Power Transmission, 1881, 96.
- OLRICK, L., decease, 1881, 11.—Memoir, 6.  
Boiler and Engine, High-Pressure, 1877, 125.  
Boiler, Lancashire, 1876, 99, 114.  
Brakes, Continuous, for railway trains, 1878, 82.  
Condenser, McCarter, 1876, 311.  
Electric Lighting, 1879, 258.  
Fire-Feeder, Frisbie Mechanical, 1876, 321.  
High-Pressure Vessels, 1878, 281, 282.  
Membership, diplomas of, 1878, 44, 562.  
Papers, premiums for, 1878, 43.  
Raising of wreck "Edith," 1878, 128.  
Safety Lamps, 1879, 237.  
Saw, Direct-Acting Circular, 1875, 132.  
Steel Boiler Experiments, 1878, 260, 262.  
Valves, Safety, 1877, 183.
- OMMANNEY, F. F., Engines, Pumping, Direct-Acting, 1874, 274.
- OPEN SPRAY TUYERE, 1876, 350. *See* Tuyere, Open Spray.
- ORANGE, J., elected Member, 1882, 475.
- ORMISTON, T., elected Member, 1880, 310.—Decease, 1883, 36.—Memoir, 22.  
Docks, Barrow-in-Furness, 1880, 329.  
Steam-ship "City of Rome," 1880, 346.
- OSBORN, W. F., elected Graduate, 1883, 594.
- OSBORNE, R. G., elected Member, 1875, 315.
- OSWELL, W. ST. J., elected Graduate, 1881, 624.
- OTTO AND LANGEN'S ATMOSPHERIC GAS ENGINE, 1875, 191. *See* Gas Engine, Atmospheric.
- UGHTERSON, G. B., Expansion, Variable Automatic, 1877, 286.
- OUGRÉE BLAST-FURNACES AND COLLIERIES, visited at Summer meeting, Belgium, 1883, 513.—Description, 538.
- OUGRÉE IRON AND STEEL WORKS, visited at Summer meeting, Belgium, 1883, 513.—Description, 541.
- OWEN, G. C. M., elected Graduate, 1876, 347.
- OWEN, W., decease, 1882, 17.—Memoir, 10.

## P.

- PACKING FOR HYDRAULIC MACHINERY, 1874, 50, 53, 138, 139, 140, 183, 190, 192, 194, 198.—1877, 363, 366, 367, 368, 369, 371, 374, 375.
- PACKING PRESSES, HYDRAULIC, 1877, 349. *See* Presses, Hydraulic Packing.
- PAGET, A., elected Member of Council, 1878, 29.—1881, 30.—1884, 21.
- Accidents, Mine, Mechanical Appliances for, 1877, 326.
- Armour, Construction of, 1879, 75, 82.
- Bath, Floating Swimming, 1875, 153.
- Blast-Furnace Working, 1883, 152.
- Boiler and Engine, High-Pressure, 1877, 128, 139.
- Boiler Feeder, Fromentin Automatic, 1882, 493, 497.
- Boiler, Lancashire, 1876, 117.
- Brakes, Continuous, for railway trains, 1878, 84, 91.
- Brakes, Effect of, upon railway trains, 1878, 486, 626.—1879, 202, 203.
- Chuck, Electro-Magnetic, 1874, 43.
- Cutting of Metals, 1883, 255, 265.
- Drilling Machines for Boiler Work, 1878, 583.
- Dynamometer, Marine-Engine, 1877, 268.
- Dynamometers, 1876, 230, 243.
- Expansion, Variable Automatic, 1877, 291.
- Expansion Gear, Automatic, 1882, 431.
- Flow of Solids, 1878, 334.
- Friction Experiments, 1883, 654.
- Gas Engine, Atmospheric, 1875, 203.
- Hammers, Power Hammers with Movable Fulcrum, 1882, 211
- Harvesting Machinery, 1881, 54.
- Heslop Engine, 1879, 94.
- High-Pressure Vessels, 1878, 284, 289.
- Injector Hydrants, 1879, 391.
- Iron and Steel, Physical condition of, 1884, 59.
- Jute Machinery, 1880, 393.
- Locomotives, Francq's Fireless, for Tramways, 1879, 631.
- Locomotives, Fuel Consumption, 1884, 116.
- Patent Laws, 1875, 185.
- Power Transmission by Ropes, 1874, 67, 68.
- Power Transmission, 1881, 99.
- President, illness of, 1884, 412.
- Puddling, Mechanical, 1876, 279.
- Railway Traffic, Cost of, 1878, 209.
- Raising of wreck "Edith," 1878, 131, 132, 136.
- Rope Gearing, 1876, 388.

## PAGET, A. (continued).

Rules, 1874, 28, 30, 32.—1875, 37, 315, 316.—1876, 28, 29, 31, 32, 34<sup>o</sup>.—  
1877, 42, 43, 44, 45, 46, 47.—1878, 35.—1879, 43, 45.—1880, 33.—  
1883, 596.—1884, 27.

Secretary, Vote to late, 1878, 27, 112.—Appointment, 1884, 78.

Shafting, Strength of, 1883, 222.

South-Wales Mineral Wagons, 1884, 434, 443.

Steam-ship "City of Rome," 1880, 348.

Steel Boiler Experiments, 1878, 242.

Steel, Chernoff's papers, 1880, 233, 237.

Steel Compression by Steam, 1880, 408, 414.

Steel, Hardening &c., 1882, 149.

Steel, Tempered, Molecular Rigidity of, 1883, 90.

Testing Machine, Single-Lever, 1882, 399.

Traction Engines in India, 1879, 528.

Tramways, Mechanical Traction, 1878, 426.

Tramways, Permanent Way, 1880, 211.

Tynewydd Colliery Inundation, 1877, 231.

Valve-Gear, Joy's, 1880, 440.

Valves, Safety, 1877, 187.

Ventilators for Mines, Mechanical, 1875, 327.

Vote of thanks to retiring President, 1880, 26.

Water Meter, Barton and West's, 1879, 451.

Water Meters, 1882, 77, 91.

Water-Power Engines, 1879, 489.

Water-Pressure Regulators, 1879, 439.

PAGET, B., elected Associate, 1874, 101.

PALCHOVDHURI, B., elected Graduate, 1883, 180.

PALMER, C. B., elected Member, 1881, 9.

PALMER, J. E., Water Meters, 1882, 96.

PALMER'S SHIPBUILDING AND IRON WORKS, visited at Newcastle meeting, 1881, 610.

PANTON, W. H., elected Member, 1877, 72.

PAPER MILL, OGI, *Paper* on the Ogi Paper Mill, Japan, by W. Anderson, 1876, 127.—Preparation of material for manufacture of paper, 127.—Sorting of rags, 127.—Cutting, 128.—Dusting, 128.—Rag boilers, 129.—Alkali-mixing apparatus, 130.—Composition of solution, 131.—Washing machinery, 132.—Poachers for bleaching, 135.—Bleach-mixing apparatus, 136.—Beaters, 137.—Size making, 138.—Paper-making machine, 139.—Strainer, 139.—Knotters, 141.—Shake-frame on which the paper is made, 142.—Vacuum boxes, 144.—Couch rolls, 145.—Press rolls, 146.—Drying cylinders, 147.—Calenders, 148.—Self-acting continuous cutting machine, 149.—Lengths of paper accurately cut by cross cutter, 150.—Difficulty

## PAPER MILL, OGI (continued).

from electricity developed by drying of paper, 151.—Polishing rollers, 152.—Steam power used in driving the mill, 152.—Erection of mill, 154.

*Discussion.*—Anderson, W., Mill worked successfully, and without skilled attendants, 155; samples illustrating processes, 155.—Amos, C. E. Revolving rag boiler found best adapted for paper making, 157.—Cowper, E. A., Construction of first machine for cutting long sheets of paper, 157.—Amos, C. E., Improvements in knives of cutting machine, 158.—Cowper, E. A., Bellows knotter, improvement on old rapping knotter, 159; square rotating knotter, 159; mode of cutting perforated plates for knotters, 159; circular knotters, 160; construction of plates in Ibotson's knotter, 160.—Amos, C. E., Square rotating knotters objectionable on account of waste caused, 160; improved plan of knotter, 161.—Anderson, W., Revolving square knotters not suitable for great regularity of work, 161; revolving rag boiler found very good, 162.

PAPERS, SUBJECTS FOR, 1874, 7.—1875, 10.—1876, 8.—1877, 7.—1878, 1.—1879, 1,

PARAGON SAFETY VALVE, description of, 1877, 184.

PARIS MEETING, 1878, 293.—Votes of thanks, 545.—Works visited and Excursions, 546.—Dinner, 548, 555.—Conversazione, 550.

PARK, J. C., elected Member, 1877, 72.

PARKER, W., elected Member, 1879, 38.

Marine Engine, 1881, 487.

PARK IRON MINE, visited at Barrow meeting, 1880, 485.

PARLANE, W., elected Member, 1884, 199.

PARRINGTON, M. W., Description of Wearmouth Colliery, 1881, 615, 616.

PARRY, H., elected Member, 1881, 624.

PARSEY, W., Steel Boiler Experiments, 1878, 245.

PARSONS, Hon. C. A., elected Graduate, 1880, 10.

PARSONS, Hon. R. C., elected Member, 1878, 558.

Brakes, Effect of, upon railway trains, 1879, 212.

Screw Propeller, *Paper* on the loss of power in the Screw Propeller, and the means of improving its efficiency, 1879, 588.—Remarks, 599, 604, 607, 608.

Water Meter, 1879, 450.

PATENT LAWS, First Special Meeting on, 1875, 163.—Bramwell, F. J., Object of the meeting, 163; patent law of 1852 not faultless, but had worked well, 164; opposition raised to patent laws, 165.—Cowper, E. A., Resolution moved, 166; patent laws very important and beneficial, 166; objections to proposed bill, 166; commissioners of patents not appointed according to 1852 Act, 167; provisional specification very useful, 168.—Smith, W., Administration of patent law would be left exclusively in the hands of the Lord Chancellor, 169; United States patent law unsatisfactory, 169;

## PATENT LAWS (continued).

longer period of protection required, 170; good patent libraries better than staff of examiners, 170.—Carpmael, W., Patent should represent opinion of competent examiners, 171; proposed court of appeal incompetent, 171.—Campin, F. W., Proper system of examination desirable, 172; provisional specification and protection very important, 173.—Newton, W. E., Resolution moved, 174; provisional specification and protection required, 174; nature of examination under proposed bill, 175; patents required for longer than seven years, 175.—Wise, W. L., Proposed examination too comprehensive, 176; adverse report very injurious to patentee, 178.—Siemens, C. W., Present patent law good, though requiring improvement, 179; examination useful if not carried too far, 180.—Napier, J. M., Provisional specification necessary, 180; difficulty in means of search, 181.—Smith, W., Accumulated fund ought to be applied in reducing charges, 181.—Carpmael, W., Expense of search conducted by private agents and by a government department compared, 182; effect of adverse reports, 182.—Wise, W. L., Effect of adverse reports, 182.—Tweddell, R. H., Resolution moved, 183; objection to indiscriminate patents for trifling improvements, 183; patent laws of this country preferable to foreign laws, if 1852 Act were fully carried out, 183.—Campin, F. W., Confusion of colonial and foreign inventions in proposed bill, 184.—Newton, W. E., English patent destroyed by lapse of foreign patent, 184.—Wise, W. L., Patents for so-called frivolous improvements, 184.—Smith, W., Power given to commissioners by 1852 Act never carried out, 184; resolution moved, 185.—Paget, A., Resolution moved, 185; patent laws very important for development of manufactures, 185.—Bramwell, F. J., Objections to proposed bill, 186.

PATENT LAWS, Second Special Meeting on, 1876, 179.—Ravenhill, J. R., Present meeting called for further consideration of the subject, 179.—Tweddell, R. H., Necessity for agitating against bill now before House of Commons, 180; resolutions moved, 180.—Crampton, T. R., Proposed bill very injudicious and prejudicial, 181.—Smith, W., Not advisable for proposed bill to be altogether negatived, but modifications required, 182.—Newton, W. E., Proposed bill should not be met with simple negative, but objections should be pointed out, 182; present patent law preferable, if 1852 Act were properly carried out, 183; paid commissioners should be appointed to carry it out properly, 184; commissioners should be appointed, not for their legal knowledge, but for their scientific knowledge, 185.—Ravenhill, J. R., Better refer bill to select committee than attempt to alter clauses, 185.—Crampton, T. R., Bill should not be thrown out, but referred to select committee, 185.—Selwyn, Adm. J. H., Principles affirmed by previous meetings, 186; patents should not be subject to law



## PATENT LAWS (continued).

officers, 187; objection to referring bill to select committee, 187.—Smith, W., Not desirable to refer bill to select committee, but House of Commons should be petitioned to alter certain clauses, 188.—Cole, Sir H., Revenue of patent office not properly applied, 189; lawyer not wanted at the head, 189; wrong appropriation of fees, 190; if present law were honestly worked, no want of any new law, 190; registration of invention should be obtained at low price, 191; best to oppose proposed bill altogether, 191.—Fletcher, H. A., Proposed bill radically bad, 191; present system of paying stamp duty in large sums very objectionable, and small annual payments recommended, 192.—Mundella, A. J., Better to propose referring the proposed bill to select committee, than its total rejection, 192; promoters of bill desire abolition of patents, 193; necessity for modifying bill could be shown before select committee, 194; amount of litigation arising from patents very small, 194.—Crampton, T. R., Necessity for united action, 195.—Ravenhill, J. R., Bill should be referred to select committee, 195.—Mundella, A. J., Commission to enquire into state of patent office, 195.

PATERSON, W. S., elected Graduate, 1880, 310.

PATON, J. M. C., elected Member, 1877, 72.

PATTERSON, A., elected Member, 1881, 9.

PATTINSON, H. L., Feed-Water Heater and Filter, 1881, 549.

Lead Processes, 1881, 536.

PATTINSON, J., elected Member, 1881, 9.

PATTISON, G., elected Member, 1883, 309.

PAUL, A. L., elected Member, 1884, 2.

PAXMAN, J. N., Iron and Steel for Boilers, 321, 326.

PEACHE, J. C., elected Member, 1880, 186.

PEACOCK, RICHARD, elected Member of Council, 1881, 30.—Vice-President, 1884, 21.

Forging of Crank Shafts, 1879, 477.

Locomotive, Brown's Tramway, 1880, 74.

PEAKER, G., elected Member, 1874, 27.—Memoir, 1884, 474.

PEARCE, G. C., elected Member, 1879, 38.

PEARSON, F. H., elected Member, 1884, 199.

PECK, W., elected Graduate, 1883, 594.

PEEL, G., JUN., decease, 1876, 3.—Memoir, 24.

PELTZER ET FILS, Cloth, Satin, Worsted, and Woollen Manufactory, visited at Summer meeting, Belgium, 1883, 516.—Note on Works, 550.

PELTZER, E., JUN., Notes on the Manufactures of Verviers, 1883, 546.

PENARTH DOCK AND TIDAL HARBOUR, description, 1874, 162.—Visited at Summer meeting, Cardiff, 1884, 357, 367-369.

PENDRED, V., Thrashing Machines, 1881, 400.

PENN, G. W., elected Member, 1884, 199.

- PENN, J., SEN., Notice of decease, and resolution of meeting, 1878, 557.—Decease, 1879, 22.—Memoir, 13.
- PENN, J., JUN., elected Member of Council, 1877, 25.—1879, 36.—1882, 32.
- PENRICE'S ROCK-DRILLING MACHINE, prevention of breaking edge &c. of tool, 1874, 95.
- PEPPER, J. E., elected Associate, 1874, 256.
- PERCY, C. M., elected Member, 1874, 101.
- PERKINS, L., Boiler and Engine, High-Pressure, *Paper* on Steam Boilers and Engines for High Pressures, 1877, 117.—Remarks, 124, 150, 152.
- Ventilator, Roots' Mine, 1877, 110.
- PERKINS, S., elected Member, 1879, 583.
- PERRETT, E., Bath, Floating Swimming, *Paper* on the Floating Swimming Bath at Charing Cross, with the means adopted for the filtration of the water, 1875, 134.—Remarks, 148, 155, 160.
- PERMANENT WAY for tramways, 1880, 188. *See* Tramways, Permanent Way.
- PERRY, A., elected Member, 1882, 476.
- PERRY, J., Electric Lighting, 1880, 282.
- PETHERICK, V., elected Member, 1882, 255.
- PETROLEUM FUEL IN LOCOMOTIVES, *Paper* on the use of Petroleum Refuse as Fuel in Locomotive Engines, by T. Urquhart, 1884, 272.—Former experiments with petroleum fuel, 272.—Localities of petroleum, 272.—Comparison of Pennsylvanian and Russian crude petroleum oil, 273.—Evaporative values of petroleum refuse and anthracite, 273.—Spray injector, 275.—Brickwork in combustion chamber, 276.—Warming of air, 276.—Spray-injector with cold air for tyre-heating furnace, 276.—Locomotives for burning petroleum, 276.—Petroleum tank on tender, 277.—Warming coil, 277.—Separation of water, 278.—Fouling of nozzle, 278.—Driving of locomotives: lighting up, 279; running, 279.—Leakage round fire-door ring, 281.—Storage of petroleum: main reservoirs, and method of charging, 281; distributing tanks, 282.—Petroleum firing for stationary boilers, 283.—Gauging of petroleum, 283.—Description of railway, 284.—Dimensions of engine and tender, 285.—Results of comparative trials of fuel consumption, 285.—Petroleum as a preventive of incrustation and of priming, 288.—Newest construction of combustion chamber, 288.—Comparison of eight-wheeled and six-wheeled locomotives, 288.—Safety of petroleum firing, 289.—Collateral advantages of petroleum firing, 289.—Use of petroleum fuel on underground lines, 289.—Tables respecting petroleum refuse, and details of trials, 290-298.
- Discussion.*—Tomlinson, J., Discrepancies in evaporative values, 299; form of locomotive boiler for petroleum firing, 299; cleansing of spray nozzle, 299; objection to petroleum fuel on Underground Railway, 300.—Boyd, W., Petroleum fuel in steamers on Caspian, 300;

# **PETROLEUM FUEL IN LOCOMOTIVES (continued).**

length of boiler tubes, 301; cost of petroleum, 301; consumption, 301; difference between summer and winter consumption, 302; rapid raising of steam with petroleum firing, 302.—Rennie, G. B., Petroleum firing in vessels navigating Tigris and Euphrates, 302.—Tartt, W., Particulars of petroleum firing in vessels on Euphrates and Tigris, 304; details of trials, 305.—Crampton, T. R., Success of petroleum fuel depends upon relative cost and heating value, 306; mixture of air, 307; loss of duty by heat going up chimney, 307.—Marshall, F. C., Necessity for longer boilers, 308; importance of air supply, 308; circulation of water while raising steam, 309; petroleum firing in return voyages from Black Sea, 309; temperature of smoke-box, 309; extreme limit of theoretical perfection, 310.—Bainbridge, E., Petroleum of no use for underground haulage, 310; rope haulage preferable to locomotives, 310; relative cost of petroleum and coal for underground haulage, 311.—Head, J., Brickwork absolutely essential inside petroleum furnace, as reservoir or fly-wheel for heat, 311; both petroleum and air should be heated beforehand, 311; mode of introduction of air, 312; smoke is a sign of insufficiency of air supply, 312.—Nurse, P. F., Experience of petroleum fuel on steamer in England, 312; prohibitive price, 313; prevention of incrustation and priming, 313.—Bedson, J. P., Firing with charcoal dust saturated with petroleum, 314.—Tomkins, W. S., Author's locomotives arranged as experimental make-shift, 314; difference of fuel consumption in winter and summer, 315.—Cardew, C. E., American kerosene and Rangoon mineral oil for preventing incrustation, 315; precautions against excessive use of petroleum, 315.—Halpin, D., Efficiency of petroleum as anti-incrustator, 316.—Bell, I. L., Proper criterion is evaporative duty, 317; two causes of loss of heat, 317; objection to too low temperature of escaping gases, 318; brickwork in furnace is not a regenerator, but a receptacle of heat for equalising temperature, 319; effect of steam jet on evaporative efficiency of petroleum, 319.—Urquhart, T., Coal in south-eastern Russia, 320; difference in evaporative value of fuel at different pressures of evaporation, 321; furnace chilled by fresh coal, 321; temporary adaptation of locomotives for liquid fuel, 321; safety of petroleum residue, 322; regulation of fire by sight-hole, 323; simple make of spray injector, 323; importance of proper arrangement of brickwork in combustion chamber, 323; cost of transport and trans-shipment of petroleum, 323; fuel consumption in summer and in winter, 324; Belpaire's arrangement of roof stay-bolts, 324; early experiments with shale oil, 324; vibration occurring where no brickwork is used, 325; fouling of spray orifices by carbonisation of petroleum, 325; brickwork essential in furnace, 325; higher efficiency of crude petroleum, 326; higher evaporative efficiency by heating both fuel and air, 327; lengthening of boiler tubes, 327;

**PETROLEUM FUEL IN LOCOMOTIVES** (continued).

introduction of air by spray injector, 327; air-passages in furnace-brickwork, 328; compressed air best for underground engines in mines, 328; warming coil in petroleum tank on tender, 329; petroleum effective and cheap as preventive of incrustation, 329; difficulty of admitting exact supply of air, 329; regenerative action of brickwork in furnace, 330; heat escaping up chimney, 330.

PHILIPSON, J., elected Member, 1881, 409.

PHILIPSON, W., elected Graduate, 1884, 409.

PHILLIPS, J., elected Member, 1878, 107.

Locomotives, Compound, 1879, 354.

PHILLIPS, R. E., elected Graduate, 1879, 584.

PHILLIPS, R. M., elected Associate, 1884, 409.

PHIPPS, C. E., elected Member, 1882, 255.

PHOSPHOR-BRONZE for slide valves, 1874, 53, 119, 199.

PHOTOMETERS for measurement of electric light. *See* Electric Lighting.

PHYSICAL CONDITION OF IRON AND STEEL, 1884, 36. *See* Iron and Steel.

PIERCY, H. J. T., elected Member, 1876, 347.

PIGOT, T. F., elected Member, 1877, 72.

PIGOTT, A. W., elected Graduate, 1883, 34.

PILLOW, E., elected Member, 1883, 309.

PINEL, C. L., elected Member, 1876, 57.

PIPES, Non-conducting covering for, 1874, 270, 276, 277.

PIRRIE, J. S., elected Member, 1882, 16.

PISTON-ROD, BACK, worse than useless, 1875, 219, 233, 235, 236, 238, 239, 243, 244, 245.

PITT, R., elected Member, 1879, 583.

PITT, W., elected Member, 1883, 179.

PITTS, G. A., elected Member, 1878, 31.—Decease, 1883, 36.—Memoir, 24.

PITWORK FOR MINE PUMPS, 1874, 267.

PLANING AND TURNING, principles of, 1878, 321.

PLATE ROLLING MACHINERY, *Paper* on improvements in Machinery for Rolling iron and steel Plates, by E. Hutchinson, 1880, 82.—Contrast between methods of rolling plates and bars, 82.—“Universal” or Belgian mill for plates, 84.—Modification for wider plates, 86.—Sliding-roll mill, 87.—Application to forge rolling, 87; to blooming, 88; to roughing-down, 88; to finishing rolls, 89.—Comparison of sliding-roll mill with Belgian mill, 89.—Rolling of steel plates, 90.

*Discussion.*—Head, Jeremiah, Rolling of Belgian “broad flats,” 91; tendency to “reediness” from mode of piling, 92; sliding-roll mill valuable for puddled bars and blooming, 92; doubtful for wide plates, from tendency to reediness, 93; mill for plates of all widths would be very

## PLATE ROLLING MACHINERY (continued).

eumbrous, 93; effect of rolling on tenacity of iron, and on its elasticity in bending, 93; sliding-roll mill more applicable for wide steel plates than for iron, 94.—Webb, F. W., In rolling steel plates from ingots, honeycombed structure must be got rid of, 94; difficulties connected with sliding-roll mill, 95.—Adamson, D., System doubtful for iron, from presence of cinder, 96; no objection with steel plates, 96; steel equally strong longitudinally and transversely, 97; drifting of holes close to edge in iron and steel plates, 97; want of evidence as to lateral strength in iron flats, 98.—Cowper, E. A., Effect of wear on sliding-roll mill, 98; means of producing fibrous structure in iron, 98; tendency of wide plates to form ragged edges, 99.

PLATES, Armour, 1879, 52. *See* Armour.

PLATT BROTHERS AND CO.'S WORKS, Oldham, description of, 1875, 308.

PLATT, E., elected Member, 1875, 35.

PLATT, J., Boiler, Lancashire, 1876, 118.

Bridge, Erection of, over river Dal, 1876, 54.

Drilling Machines for Boiler Work, 1878, 588.

Dynamometer, Marine-Engine, 1877, 268.

Engine Recorder, 1884, 160.

Expansion Gear, Correy, 1878, 524.

Hydraulic Machinery, Toulon, 1878, 386, 387.

Hydraulic Machinery, Workshop, 1874, 188.

Injector, Automatic, 1884, 181.

Iron and Steel for Boilers, 1879, 317, 319.

Presses, Hydraulic Packing, 1877, 367.

Rules, 1876, 29.

Valve, Circular Slide-, 1877, 204.

PLATT, J. E., elected Member, 1883, 179.

PLATT, S. R., Filter, Farquhar, 1881, 159.

PLATTS, J. J., elected Member, 1878, 31.

Steel Boiler Experiments, 1878, 263, 265.

PLOUGHS for horse-power: Hornsby's, 1880, 548; Howard's, 548; Ransomes Sims and Head's, 548. *See* Cultivation by Horses.

PLUM, T. W., decease, 1879, 22.—Mémorial, 15.

Rules, 1877, 34.

PNEUMATIC MARINE GOVERNOR, 1879, 406. *See* Governor, Marine.

POILLON, L. M. J., elected Member, 1884, 2.

Pump, Greindl Rotary, *Paper* on the Greindl Rotary Pump, 1878, 440.—Remarks, 465.

POIRÉE'S Experiments on friction with skidded wheels, 1879, 209.

POLE, W., Gauge, Railway, *Paper*, Notes on the early history of Railway Gauge, 1875, 66.—Remarks, 76, 87.



POLLOCK, J. F. M., elected Member, 1876, 57.

PONTYPRIDD BRIDGE, early single-arch bridge, 140 ft. span, 1874, 234.—1884, 357.

PONTZEN, E., Brakes, Effect of, upon railway trains, 1878, 484.

POOLEY, H., JUN., elected Member, 1876, 347.

PORTABLE RAILWAYS, *Paper on Portable Railways*, by P. Decauville, 1884, 126.—

Early narrow-gauge railways, 126.—Festiniog line, 126.—Portable railway entirely of metal, 126.—Adaptability to various purposes, 127.—Steel rails and sleepers riveted together, 127.—Dished steel sleepers not projecting beyond rails, 128.—Dished bowl sleepers for soft ground, 128.—Jointing of rails, 128.—Curves, 128.—Weight and gauge of rails, 129.—Description of contractors' plant, 129.—Tipping wagons, 129.—Couplings, 130.—Cost of haulage, 130.—Plant for horse haulage, 130.—Special plant for heading of submarine tunnel, 131.—Military railway in Turkestan, 131; in Tunis, 132.—Passenger, ambulance, and goods wagons, 132.—Transport of cannon, 132.—Permanent narrow-gauge line from Sousse to Kairouan, 133.—Cheap railways cannot be constructed on normal-gauge system, 133.—Narrow-gauge railway and plant for Buenos Ayres, 133.—Transport of sugar cane, 134.—Transport of boats on exploring expeditions, 135.—Accessories, 137.—Off-railer, 137.—Switches and crossings, 137.—Turntables, 137.—Dead plates, 138.—Facilities for repairs, 138.

*Discussion.*—Kerr, J., Detached sleepers can be used without impairing accuracy of gauge, 139; sleepers would be better if made trough-shape, and projecting beyond rails, 140; shoe-plate with clip-jaw makes better joint than light fish-plates with single bolt, 140; fish-joint with four bolts is best for permanent work, 141; light railway for India with trough-formed sleepers, 141.—Hartley, J. W., Importance of details in portable railways, 141; rail fastening, 141; buffers and axle-boxes, 142; points and crossings, 142; off-railer, 143; turntables, 143.—Carbutt, E. H., Narrow-gauge line and locomotives in Crewe works, 143; importance of transport in war, 144; portable railway with long gantries for unloading ships, 144.—Ramsbottom, J., Railway of 18-inch gauge at Crewe, 145.—Cochrane, C., Bowl sleepers for soft ground, 145; high speed is not the object of portable lines, 146.—Fleteau, C. L., Thickness of metal in sleepers is proportioned to strength required, 146; trial of projecting and non-projecting sleepers, 147; objection to shoe-plate with clip, 147; crossing and switch, 147; buffers, 148; turntables, 148.—Spon, E., Importance of accurate gauge, 149; sponge axle-box, 149.—Kerr, J., Construction of shoe-plates, 149.

PORTISHEAD DOCKS, visit to, 1877, 297.

PORTLAND CEMENT. *See* Cement, Portland, 1875, 46.

POWELL, H. C., elected Member, 1878, 293.

POWELL, T., elected Member, 1874, 101.

Electric Lighting, 1878, 543.

Expansion, Variable Automatic, 1877, 286.

Expansion Gear, Correy, *Paper* on vertical compound engines fitted with Correy's variable Expansion Gear, 1878, 504.—Remarks, 525.

POWELL, W., decease, 1883, 36.—Memoir, 25.

POWER HAMMERS with a Movable Fulcrum, 1882, 204. *See* Hammers.

POWER RIVETER, MacColl's, 1879, 271. *See* Iron and Steel for Boilers.

POWER TRANSMISSION, *Paper* on the various modes of Transmitting Power to a distance, by A. Achard, 1881, 57.—Transmission by WIRE ROPES, 58.—Principles of transmission by ropes, 58.—Leather and india-rubber belts, 60.—Iron wire ropes, 61.—Size &c. of pulleys, 62.—Strength &c. of ropes, 62.—Working tension of ropes, 64.—Efficiency of rope transmission, 65.—Transmission by COMPRESSED AIR, 66.—Principles of air-compressors, 67.—Screwing water-piston compressor, 67.—Cooling of compressed air by water, 68.—Efficiency of compressors, 68.—Loss by friction in pipes, 69.—Stockalper's experiments in St. Gothard tunnel, 71.—Motors supplied by compressed air, 73.—Mekarski's compressed-air tramway engine, 79.—Efficiency of air transmission, 75.—Transmission by PRESSURE-WATER, 76.—Applications of water pressure, 76.—Loss by friction in pipes, 77.—Schmid's piston water-engine and Girard's turbine, 79.—Efficiency of water-engines, 80.—Transmission by ELECTRICITY, 80.—Generators of electricity, 81.—Hagenbach's experiments on efficiency of ditto, 82.—Motors driven by electric current, 83.—Efficiency of electric transmission, 84.—Estimation of efficiency in different methods of transmitting power, 85.

*Discussion.*—Shoolbred, J. N., Conversion of Hagenbach's experiments into English terms, 87; electric transmission of power, 89; application to lighting, 90; to electric railway, 90; to ploughing, 91.—Siemens, A., Advantages of electric transmission of power, 91; other applications by Dr. Siemens, 92; determination of efficiencies, 92.—Ferne, J., Application of water-power at Geneva, &c., 93; use of steel for wire ropes, 94.—Schönheyder, W., Adhesion of wide leather belts, 94; short duration of wire ropes, 95; water-piston air-compressors, 95; loss by friction in pipes, 95; transmission of power by steam, 96.—Mair, J. G., No vacuum between belt and pulley, 97; loss from waste spaces in water-pressure machines, 98.—Rich, W. E., Advantage of low pressures in compressed-air transmission, 98; inconvenience of ice in ports of compressed-air engines, 98; difficulty in working slide-valves in water-engines, 98.—Paget, A., Vacuum under belt at great speed a mistake, 99.—Ellington, E. B., Distribution of hydraulic power in Hull, 99.—Cowper, E. A., Transmission by flat-rods in Cornwall and Devon, 99; steel preferable to iron for wire ropes, 100.—

## POWER TRANSMISSION (continued).

Achard, A., Commercial failure of rope transmissions at Bellegarde and Fribourg, 100; results at Schaffhausen and Zurich, 100; transmission by water-pressure at Geneva, 101; use of wide driving belts, 102; advantage of low-pressure for compressed-air transmission, 102; importance of efficiency, 102; loss from waste spaces in water-engines, 102; loss of power in water-piston air-compressors, 103; steel ropes now coming into use, 103; advantages over iron ropes, 104.

POWER TRANSMISSION BY ROPES, *Paper on the Transmission of Water Power by Turbines and Wire Ropes*, by H. M. Morrison, 1874, 56.—Sites for water power not utilised, 56.—Telodynamic transmission of power by quick-running light wire rope, 56.—Hirn's plan applied first at Haussmann's factories at Loyelbach, 57.—Deflection of ropes transmitting power, 59.—Largest example at the Wasserwerk-Gesellschaft in Schaffhausen, 60.—Turbine house, 61.—Turbines, construction, 62.—Transmission of power across the river Rhine by wire ropes, 63.—Rope pulleys and machinery, 64.

*Discussion.*—Siemens, C. W., Power transmission by ropes at high speed effected with very little loss, lately applied at Bellegarde on the Rhone for transmission of power for more than a mile, 65; soft material required for bearing surface of rope on pulleys, 65.—Thomas, J. L., Ropes employed in Aviero lead mining district, Portugal, conveying water power for nearly a mile over a considerable hill, 65; grooves of rope pulleys lined with leather placed edgeways, 66; turbine driving rope can be stopped by electrical communication from mine, 66; speed of rope 30 miles an hour, transmitting about 100 horse power, 67.—Anderson, W., Wire ropes driving cranes found to last two years, 67; failures from stranding of ropes caused by defective workmanship, 67.—Paget, A., Adhesion of rope in grooves of pulleys, 67.—Robinson, J., Friction on sides of grooves detrimental to rope, 68.—Tweddell, R. H., Estimated loss of power in transmission, 68.—Browne, W. R., Pump in cofferdam in Avon at Bristol worked by rope from shore, 68.—Welch, E. J. C., Failure of strands of wire ropes caused by ends of wire being merely joined by twisting instead of brazing in manufacture of rope, 70; power more economically transmitted by turbines forcing water through small pipes under accumulator pressure, avoiding wear and friction of ropes and pulleys, 70.—Walker, C. C., Importance of utilising waste forces of water, 70.—Gray, J. McFarlane, Cost of transmission of power, 71.—Westmacott, P. G. B., Water power transmitted to a distance by Sir Wm. Armstrong at Allenheads lead mines, Northumberland, by force pumps worked by waterwheels for charging accumulator, 71; advantage in avoiding the wear of ropes, 71.—Bramwell, F. J., Schaffhausen water-power machinery in 1869, extent of works, mode of carrying ropes, 72.—Smith, W., Power

## POWER TRANSMISSION BY ROPES (continued).

transmission by endless wire ropes driven by engine tried for towing boats on Regent's Canal, London, in 1840, but not found economical, 72; fly-rope of old rope-making machinery communicated motion to spindles, 73.—Morrison, H. M., Means of utilising waste water power in mountainous districts, 73; ropes at Schaffhausen made very compact with large number of fine wires, American examples still finer and closer, 73; willow wood succeeds best for lining grooves of rope pulleys, 74.—Coode, Sir J., Wire ropes employed for hauling at Portland breakwater, and protected from sea-water corrosion by coating of tar and linseed oil, 74; advantage of coating formed on the drums, 74.—Morrison, H. M., New wire ropes at Schaffhausen soaked in steam-jacketed cisterns of wood tar, and afterwards tarred three times per week, 74.—Hawksley, T., Friction of water through pipes increases as square of velocity, but friction of ropes as simple velocity, consequently resistances will be equal at a certain speed, 75.—Siemens, C. W., Transmission of power by rope involves only one prime mover, but transmission by hydraulic accumulator involves two prime movers and two losses of useful effect, 75.—Bramwell, F. J., Desirability of utilising water power, even at same cost as coal, 75; coal should be reserved for supplying heat in metalliferous operations &c., 76; other modes of transmitting power, 76; Hague's proposal for transmitting water power from hilly districts by exhaustion of air, 76.

POWER TRANSMISSION BY ROPES. *See also* Rope Gearing, 1876, 372.

PREECE, W. H., Electric Lighting, 1879, 250.—1880, 280.

Steel, Tempered, Molecular Rigidity of, 1883, 88.

PREMIUMS FOR PAPERS, 1878, 43, 114, 564.—Olick, L., Premiums which had been proposed but not given were too high, 1878, 43.—Robinson, J., Question would be considered, 44.—Resolution of Council, 564.

PRESIDENTS, election, 1874, 26.—1875, 34.—1876, 26.—1877, 25.—1878, 28, 32.—1879, 36.—1880, 24.—1881, 30.—1882, 32.—1883, 53.—1884, 21.—Address, 1874, 103.—1877, 167.—1878, 295.—1879, 399.—1880, 28, 312.—1881, 413.—1882, 259.—1883, 317.—1884, 202. *See* Addresses of Presidents.

PRESSER, E. C. A., elected Member, 1882, 16.

PRESSES, HYDRAULIC PACKING, *Paper* on an improved construction of Hydraulic Presses for packing cotton, jute, &c., with improved engines and pumps, by R. Wilson, 1877, 349.—Advantage of working presses and other hydraulic machinery at high speed, 349.—Successful working of quick-speed two-cylinder hydraulic press in India, 350.—Description of three-cylinder press, 350.—Steel cylinders in place of iron, 351.—Auxiliary finishing press, 352.—Compound press for finishing bale without removal from press, 352.—Horizontal press to avoid expense of two-storied buildings,

## PRESSES, HYDRAULIC PACKING (continued).

353.—“Cross-packing” of cotton, an objection to be avoided, 353.—Number of direct-acting pumps used, and mode of working, 354.—Advantage of direct-acting engines for packing presses, &c., 354.

*Discussion.*—Wilson, R., Horizontal press more convenient than vertical, 354.—Shield, H., Diagram showing increase of pressure during stroke of press, 355; description of Watson compound press for cotton, 355; no pressure yet applied has injured the fibre of cotton for spinning, 357; best pumping arrangement is a large number of small pumps easily thrown in or out of action, 357; direct-acting pumps more expensive in working, 358; speed of packing bales, 359; press must not cross-pack either cotton or jute, 360.—Walker, B., Use of accumulator in seed pressing, 361.—Wilson, R., Accumulator necessary where only one press is used, 362.—James, C., Small accumulator found to act well for pressing oil, 362; hemp or flax packing simpler than cup-leathers, 363.—Wilson, R., Cup-leathers often made too broad, 363; cup-leathers best for high pressures, 363; advantages of direct-acting engines and pumps, 364.—Cowper, E. A., Compound press best for packing cotton, 364.—Tweddell, R. H., Single direct-acting pump preferable for working the press, 365; hemp packing best for heavy pressures and continuous working, 366.—Davey, H., Best construction of cup-leathers, 366; brass saddle turned exactly to fit inside of leather, 367.—Platt, J., Difficulty from thin edge of back supporting-ring of cup-leather springing against ram, 367.—Davey, H., Ring must not be tapered to a perfect feather edge, 367.—Welch, E. J. C., Packing rings of different materials, 367; best proportions for leather packing rings, and method of moulding, 369; hemp packing now adopted instead, and found perfectly tight, 369.—Bellhouse, E. T., Steel cylinders now made very successful for hydraulic presses, 369; improved form of presses for India, 370; best plan of leather packing rings, 371.—Chapman, J. G., Great increase in cost of working hydraulic presses with quick speed of pumps, 371; cranked shafts best for driving pumps, 372.—Lewis, G., Description of Ashcroft packing press, worked by combined steam and hydraulic power, 372; packing leathers generally made too deep, 374.—Wilson, R., Comparison of direct-acting pumps and those worked by eccentrics, 374; packing leather cannot be too narrow, so long as it is watertight, 375; rams covered with gun-metal and highly polished reduce wear of packing leathers, 376.

PRESSES, HYDRAULIC. *See* Pressure-Intensifying Apparatus. *See also* Hydraulic Machinery, Toulon.

PRESSURE GAUGES, 1880, 455-476. *See* Gauge.

PRESSURE-INTENSIFYING APPARATUS, *Paper on the Application of direct-acting Pressure-Intensifying Apparatus to Hydraulic Presses*, by R. H. Tweddell,



## PRESSURE-INTENSIFYING APPARATUS (continued).

1878, 45.—Saving by introducing best system of press, 45.—Defects in usual mode of forcing water into cotton and other presses, 46.—Description of direct-acting apparatus, 47.—Mode of working, 48.—Dimensions of a cotton-bale pressing plant constructed on direct-acting principle, 50.—Power and speed of press, 51.—Reasons for advocating extension of direct-acting principle, 52.—Relative economy of Watson and Wilson press, 52.—Difference in cost of fuel is not due to difference in pumps, 53.—Nor to different velocity of water through pumps, 54.

*Discussion.*—Robinson, J., Cost of pressing is remarkably low, 55.—Shield, H., The direct acting press is a re-pressing apparatus, showing American practice, 56; English practice for India is different, 56; number of bales in the two processes cannot be compared, 57; number of beats of valves is not of much consequence, 59; direct-action press is not economical, 59.—Ellington, E. B., Description of West's press, 59.—Robinson, J., Cotton is damaged only by being squeezed in two directions, 60.—Cowper, E. A., Nature and evil of cross-packing, 60; danger from heat in rapid pressing, 61.—Shield, H., Impossible to injure cotton by heavy pressure, 62.—Hawksley, T., Not desirable to put too great pressure on cotton in pressing, 63.—Carbutt, E. H., Direct-acting steam and hydraulic press for punching plates for gasometer making, 63.—Hetherington, T. R., Alleged injury to cotton is not a matter of moment, 63.—Tweddell, R. H., Paper was meant to elicit discussion as to question of pumps, 64; direct-acting process would be economical, 65; loss with reciprocating pumps must be heavy, 65; source of economy in direct-acting system, 65.

PRESSURE REGULATORS, 1879, 423, 434. *See* Water Pressure.

PRESSURE, WATER, application of, for driving machinery and working shop tools, 1874, 166. *See* Hydraulic Machinery, Workshop.

PREST, S. F., elected Member, 1884, 409.

PRESTON, F., Condenser, McCarter, *Paper* on the McCarter Condenser without air-pump for steam engines, 1876, 299.—Discussion, 308, 310, 315, 316.  
Rope Gearing, 1876, 397, 398.

Steel, Fluid-Compressed, and Guns, 1875, 302.

PRICE, H. S., elected Member, 1877, 165.

PRICE, J., Secretary, appointment, 1884, 77.

Ships, *Paper* on Iron and Steel as constructive materials for Ships, 1881, 553.—Remarks, 574.

PRICE-WILLIAMS, R., elected Member of Council, 1880, 24.—1883, 53.

Accidents, Mine, Mechanical Appliances for, 1877, 330.

Armour, Construction of, 1879, 75.

Axlebox, Radial, 1877, 309.

## PRICE-WILLIAMS, R. (continued).

- Brakes, Automatic Action, 1880, 133.  
 Brakes, Effect of, upon railway trains, 1879, 208.  
 Cold Air, Machines for producing, 1881, 129.  
 Council, Annual Report, 1884, 21.  
 Docks, Cardiff, 1874, 134.  
 Drilling Machines, 1878, 583.  
 Flow of Solids, 1878, 331.  
 Friction Experiments, 1883, 658.  
 Injector Hydrants, 1879, 384.  
 Railway Traffic, Cost of, 1878, 195-202, 208, 209, 214.  
 Railway Working, *Paper on the Economy of Railway Working*, 1879, 96.  
     —Remarks, 135, 146, 151.  
 Rules, 1877, 32.—1878, 34, 39.—1879, 42, 44.  
 Saw, Direct-Acting Circular, 1875, 131.  
 Secretary, Vote to late, 1878, 111.  
 South-Wales Mineral Wagons, 1884, 426.  
 Stone-Dressing Machinery, 1881, 141.  
 Testing Machine, Single-Lever, 1882, 392.  
 Tramways, Mechanical Traction, 1878, 432.  
 Tramways, Permanent Way, 1880, 218.  
 Water Meters, 1882, 80.

PRINTING MACHINERY, *Paper on Printing Machinery*, by J. Jameson, 1881, 511.

—Platen, Cylinder, and Rotary machines, 512.—Making of stereotype plates, 514.—Type setting, 515.—Stereotyping, 515.—Rapidity of work, 516.—Printing machine for *Newcastle Daily Chronicle*, 517.—Gathering and folding apparatus, 520.—Hydraulic lifts, &c., 522.—Advantages of Hoe printing machine, 522.

*Discussion.*—Steavenson, A. L., How are wood-cuts introduced in newspapers, 523.—Cowper, E. A., Can wood-cuts be stereotyped, 523.—Jameson, J., Wood-cuts can be stereotyped to limited extent, 523.—Nurse, P. F., Illustrated newspapers usually not printed on rotary machines, 523.—Shaw, H. S. H., Changing of blanket on impression roller, 524.—Jameson, J., Blanket changed bodily, 524.—Cowper, E. A., Ink distribution, 524; width of paper and springing of cylinders, &c., 524; casting of stereotype plates, 525.—Jameson, J., Absence of spring in impression cylinder, 525.

PRIOR, J. A., elected Member, 1875, 36.

PROCEEDINGS, Purchase of, 1879, 156.

PROJECTILES against Armour Plates, 1879, 52. *See* Armour.

PROPELLER, Efficiency of, 1879, 588. *See* Screw Propeller.

PROPULSION, HYDRAULIC, 1874, 290, 292.

PROSSER, W. H., elected Member, 1874, 27.

PROVING HOUSE, Lloyd's Bute Proving House, Cardiff, 1884, 364.

PROVIS, G. S., elected Member, 1875, 36.

PUDDLING FURNACE, BICHEROUX, 1883, 541.

PUDDLING, MECHANICAL, *Paper on Mechanical Puddling*, by T. R. Crampton, 1876, 244.—Good puddler not only makes better iron but with less loss of weight than bad puddler, 244.—Mechanical puddling superior to hand labour both in yield and quality, 245.—Different arrangements for mechanical puddling, 245.—Walker and Warren's, 245.—Maudslay's, 245.—Tooth's, 245, 246.—Danks', 246.—Sellers', 246.—Siemens', 246.—Crampton's dust-fuel furnace, 246.—Coal feeder, 247.—Mechanical rabble not so useful as revolving drum, 247.—Principle of revolving puddling furnace, 248.—Mechanical rabble only saves a portion of manual labour, 249.—Revolving system heated by separate furnace still requires intelligent adjustment of flame, 249.—Dust-fuel consumed in puddling chamber is regulated automatically, 250.—Results of working with dust-fuel furnace, 250.—Weight of mass operated upon is of little importance, 250.—Iron obtained from large homogeneous mass is superior to that obtained by piling, 251.—Quality improved by more effective puddling in revolving chamber, 251.—Best mode of producing heat in furnace, 252.—Joint for preventing leakage of liquid metal, 252.—Furnace re-fettled automatically, 253.—Advantages derived from dust-fuel furnace, 253.—Examples of superior results of mechanical puddling over hand puddling, 254.—Homogeneous plates and rails made from inferior pig, 255.—Case-hardened rails could be produced by mechanical puddling as cheap as ordinary iron rails, 255.—Homogeneous material superior in every respect to that built up of pieces, 256.—Particulars of specimens, 257.

*Discussion.*—Crampton, T. R., Description of specimens exhibited, 259.—Webb, F. W., Iron manufactured in Crampton furnace perfectly clean and good, 260; analysis of iron in different stages from pig to finished steel rails, 260; comparative cost of making rails by Siemens-Martin and by Bessemer process, 261.—Newton, W. E., Paper very complete in giving history of invention of mechanical puddling, 261; early plans for superseding hand-puddling, never carried into practical execution, 261; Tooth's apparatus actually carried out in practice, and worked well, but would not last, 262; subsequent difficulty of getting sufficiently good fettling, 263; necessity for keeping rotating cylinder cool, first really recognised in Crampton furnace, 263; plan for generating heat in that furnace, not the best, 263; uncombined carbon should not be carried into puddling chamber, 264; desirable to know comparative consumption of fuel in dust-fuel furnace per ton of iron, 264; Spencer's rotating puddling furnace, 264; variation in size of puddled balls, 265.—Head, J., Dr.

## PUDDLING, MECHANICAL (continued).

Kollmann's experiments on process of puddling in ordinary furnace at Königshütte Iron Works in Silesia, 266; analyses of pig iron at certain stages of puddling, 266; analyses of fettling, showing that as impurities decrease in iron they increase in fettling, 267; puddlers not overpaid, 268; rollers and heaters often overpaid, 269; increased yield of iron in some cases due to good fettling instead of to skill of puddler, 269; mechanical rabble better than hand-puddling furnace, 269; result of Crampton furnace at his own works, 270; requisite heat could be obtained with powdered fuel, but labour and expense of feeding the fuel perhaps underrated, 270; difficulty not yet surmounted of making plates without defects, 271; mechanical puddling not the invention of one mind, 272.—Carbutt, E. H., Wrought iron becoming superseded by steel, 272; appliances for manipulating large balls of iron, not right way of dealing with them, 273; dust-fuel furnace gives means of utilising inferior qualities of pig-iron, 273.—Walker, B. P., Original invention of revolving puddling furnace was actually put in operation, 274; results of experiments with original furnace, 274.—Cochrane, C., Means required for dividing large balls of iron to suit existing rolling machinery, 275.—Lloyd, S. Z., Information required as to cost and quality of fettling, 275.—Cowper, E. A., Production of large homogeneous masses more important than reduction in cost of puddling, 275; mechanical puddling of special importance for Staffordshire, 276; iron puddled in Crampton furnace better than that made by hand, 276; Danks furnace fettled with oxide of iron, and more iron brought out than pig put in, 277; cooling of Crampton furnace very complete, 277; Crampton rotator certainly works well, 278; doubt about cost of grinding powdered fuel, 278; good fettling required for all rotary furnaces, 278; not much difficulty in cutting up large balls when required, 278; advantages of Crampton furnace, 279.—Carbutt, E. H., Plates made from puddled bars piled for rolling, 279.—Whitworth, Sir J., Importance of ascertaining tensile strength of all specimens, 279.—Paget, A., Sufficient heat going up the chimney both to dry and to grind the coal, 279.—Bramwell, F. J., Comparative yield of hand furnaces with equal fettling, 280; steel should be recognised as a superior material to iron, 281.—Head, J., Cost of drying coal arises not so much from fuel used as from labour expended, 281; Crampton furnace requires better fettling than ordinary furnaces, but gives greater yield, 282; rotary furnace removes impurities to greater extent than ordinary furnaces, 282; objection of lamination but little felt in boiler-shell plates and ship plates, 283; large plates better made from a single ball if practicable, 283; consumption of coal in Crampton furnace per ton of puddled bloom, 283.—Cowper, E. A., Cinder from ordinary hand furnace and from rotary

## PUDDLING, MECHANICAL (continued).

furnace should be analysed to see what good done by each, 284.—Adams, T., Mode of use of dust fuel in a furnace at Boston, U.S., 284.—Shanks, A., Indian charcoal-pig treated in Crampton furnace made very good iron, 285.—Siemens, C. W., Question mainly one of obtaining fettling of sufficient resisting power, 285; furnace for puddling ore direct avoided impurities put into iron in blast furnace, 286; water casing introduced in Crampton furnace very good, 287.—Crampton, T. R., Good economy to have best fettling that can be obtained, 287; certain good results obtained by Walker's original trial, but cold-short iron produced, 288; Spencer's furnace did remarkably good work, but did not last long, 288; liquid fettling very good for re-fettling after wear, 289; dust-fuel furnace at Woolwich seems to have no practical objection, 289; laminated plates not so good as homogeneous ones, 290; iron made from common Cleveland pig in dust-fuel furnace as good as any other produced, 291; impurities eliminated from pig better than in other puddling furnaces, 291; iron must give way to steel unless better material made in general, 292; manipulation of large blooms not difficult, 292; cost of fettling should not be considered, as best quality could be employed with profit, 292; ductility of iron produced from dust-fuel furnace, 293; cost of drying fuel for grinding is only a secondary consideration, 294; perfect combustion of fuel in furnace, 294; process of making malleable iron in India, 294.—Hawksley, T., Quality of iron should be considered in England, and not quantity made, 295; most important that phosphorus should be removed from iron, 296; Siemens gas furnace likely to turn out purer material than Crampton dust-fuel furnace, 297.

PULLEYS FOR WIRE ROPES, 1874, 64, 66, 74.

PUMP, Bucket Lift, 1874, 268.—Centrifugal, 293.—Helical, 281.—Jet, 292.—Plunger, 268.—Valves for, 269.

PUMP, GREINDL ROTARY. *Paper on the Greindl Rotary Pump*, by L. Poillon. 1878, 440.—Importance of pumps is as great as that of motive power, 440.—Reciprocating pumps, 440.—Rotary pumps, 441.—Disadvantages of those hitherto in use, 441.—Greindl pump, 442.—Diagrams showing action of any form of rotary pump, 442.—Low mechanical efficiency of existing pumps, 443.—Greindl pump is designed to overcome this, 444.—Description and advantages of Greindl pump, 445.—Uniformity in pressure and velocity of water, 446.—Lateral pockets provided for this object, 448.—Practical trials of Greindl pump at Brest, 450.—Height of suction, 451.—Losses by leakage, 452.—Losses by friction, 453.—Greindl pumps proposed for Ourcq water works, 454.—Gearing and wear, 455.—Applications of Greindl pump, 457.—Pumps for raising water alone, 457.—Pumps for raising a mixture of water and air, 458.—Pumps for compressing or exhausting air,



## PUMP, GREINDL ROTARY (continued).

460.—Pumps for hydraulic propulsion of ships, 462.—Pumps used as ventilators or gas exhausters, 462.

*Discussion.*—Ellington, E. B., Greindl pump has worked well at Hull under difficult circumstances, 464.—Hawksley, C., Equal percentage of useful effect can be obtained with ordinary beam pumping engine, 465.—Ellington, E. B., Useful effect at Hull was 50 per cent., 465.—Poillon, L., Each height of lift has an appropriate speed, which gives greatest efficiency, 465.—Robinson, J., Pump would become very valuable for certain operations, 465.

PUMP, HELICAL, *Paper* on the Helical Pump, by John Imray, 1874, 281.—Application of turbine in an inverse manner for obtaining rotary motion, 281.—Design and action of helical pump, 282.—Construction of pump, 283.—Advantages compared with other rotary pumps, 284.—Experiments for testing efficiency, 285.—Percentage of efficiency, 286.—Applications of helical pump, 288.

*Discussion.*—Imray, J., Helical pump better than other rotary pumps for forcing water to higher level, not so good for suction from lower level, 289.—Siemens, C. W., Pump cannot raise water from lower level unless previously charged, 289.—Imray, J., Foot-valve is required, 289.—Cowper, E. A., Depth from which pump would draw, 289.—Imray, J., Helical pump more effective in suction when horizontal than when vertical, 290.—Siemens, C. W., Helical pump avoids changes of direction in the water and consequent loss of power from eddies, 290; advantages as a turbine and as a propeller, 290.—Imray, J., Combined helical pumps working one into another, 291.—Reynolds, E., Helical pump, if used as a propeller, has advantage of reversing like a paddle wheel, 292; experiments on water ejectors or jet pumps, 292; centrifugal pump working without foot-valve, 293.—Amos, C. E., Centrifugal pump better for raising large quantities of water, 293.—Cowper, E. A., Depth from which pump would draw, 294; advantages of helical pump compared with centrifugal pump, 294.—Brotherhood, P., Application of helical pump to hydraulic propulsion, 294.—Imray, J., Helical pump not required to be larger than centrifugal pump, 295.

PUMPING ENGINES AND PUMPS, for high lifts in mines, 1874, 258. *See* Engines, Pumping, Direct-Acting.

PUMPING ENGINES, Bull, 1874, 259.—Compound, 265.—Cornish, 258.—Differential, 260.—Horizontal rotary geared, 260.—Rotary beam, 259.

PUMPING ENGINES, useful effect, 1878, 464.—Cut-off gear, 523.

PUMPING MACHINERY FOR DOCKS, 1874, 145. *See* Docks, Pumping Machinery.

PUMPS FOR HIGH LIFTS. *See* Engines, Pumping, Direct-Acting, 1874, 258.

PUMPS for sinking shafts through sand, 1880, 485. *See* Sand Pump.

PUNCH, American Spiral (Kennedy's), 1878, 235, 239, 243.

PUNCHING. *See* Steel Boiler Experiments. *See* Flow of Solids. *See* Hydraulic Machinery, Toulou.

PUNCHING MACHINE, HYDRAULIC, 1874, 171.

PUPLETT, S., elected Member, 1884, 2.

## Q.

QUARRIES, visited at Glasgow meeting; Sim and Co., 1879, 580.

QUILLACQ, A. DE, elected Member, 1878, 558.

## R.

RADFORD, R. H., elected Member, 1878, 107.

RADIAL AXLEBOX, 1877, 304. *See* Axlebox, Radial.

RAFAREL, W. C., elected Member, 1884, 199.

RAILS, cold-rolling of iron rails, 1878, 333, 338, 341.—Tramway rails, 423, 434, 435, 439.—Wear of rails on ascending and descending railway gradients, 202, 204, 208, 209.

RAILS, Steel, saving compared with iron rails, 1879, 128, 129.—Wear, 130. *See* Railway Working.

RAILWAY BRAKES. *See* Brakes.

RAILWAY ELECTRIC SIGNALS, *Paper* on the application of Electro-Magnets to the working of Railway Signals and Points, by I. A. Timmis, 1884, 444.—Main features of improved electro-magnet, 444.—Range and strength of pull, 444.—Ordinary form of electro-magnet and solenoid, 445.—Currie long-pull magnet, 445.—Uniformity of pull, 446.—Double length of pull, 447.—Railway signals, 448.—Electric current, 449.—Power and cost, 450.—Batteries employed, 451.—Railway points, 451.—Advantages, 452.—Signals, 452.—Points, 452.—Application to railway junctions, 453.—Station to station signalling, 454.

*Discussion.*—Timmis, I. A., Railway electric signals now in work, 454; influence of weather, 455; small signal at Swansea, 455; signals go to danger automatically, 456; working of constant and intermittent currents, 456; treadle for breaking contact, 456; reduction of current from pulling to retaining, 457; repeater-arm and lamp, 457.—Crompton, R. E. B., Electric transmission of power, 458; capabilities of electro-magnets, 458; difficulty of providing electric currents along railway, 459; question of cost, 459; difficulty of perpetually making and breaking contacts, 460; various forms of long-pull magnet, 460; adjustment of force by counterweight, 460.—Walker, S. F., Increased length of pull by leverage, 461; action of

## RAILWAY ELECTRIC SIGNALS (continued).

solenoid magnet, 462; buffer to receive impact, 462; Faulkner's Altandæ magnet, 463; economy of magnet, 463; smaller currents might be used, 464; strength of current for colliery signals, 464; length of effective pull, 465; troubles with switches and contacts, 465; difficulty of providing electric power, 465; breaking of contact implies making of contact, 466.—Davey, H., Number of battery cells for working signal, 466.—Timmis, I. A., Battery power for one signal will suffice to work a number, 466; transmission of electric power, 467; experience at Swansea, 467; utilisation of spare motive power, 467; Lalande battery, 467; results from Currie magnet and from ordinary solenoid, 468; details of construction of Currie magnet, 468; adjustment of force of pull, 469; various forms of armatures, 469; saturation of armature plate, 470; use of maximum pulling current and minimum retaining current, 470.

RAILWAY GAUGE, 1875, 66.—1877, 158. *See* Gauge, Railway.

RAILWAY, ST. GOTHARD, *Paper* on the Construction and Working of the St. Gothard Railway, by E. Wendelstein, 1883, 463.—General design, 463.—General construction, 466.—Principal tunnels, 468.—Principal iron bridges, 470.—Tunnelling, 469.—Brandt hydraulic rotary drill, 469; work done by ditto, 473; comparison with Frölich drill and hand work, 474.—Ventilation of St. Gothard tunnel during construction, 474.—Temperatures in heading of St. Gothard tunnel, 475.—Ventilation of spiral tunnels during construction, 477.—Ventilation of St. Gothard tunnel after completion, 479.—Present condition of ventilation in St. Gothard tunnel, 479; in spiral tunnels, 482.—Influence of traffic on ventilation, 484.—Ventilation as affected by gradients, 486.—Locomotives, 486.—Hauling power of locomotives, 488-9.—Carriages and wagons, 490.

*Discussion.*—Trasenster, L., Sommeiller's use of compressed air for Mont Cenis tunnel, 491; advantages of Brandt drill, 491.—Rathbone, E. P., Advantage of Brandt drill for mining, 492.—Westmacott, P. G. B., Hydraulic drill at Allenhead lead mines, 492.

RAILWAYS, Notes on Belgian Railways, by P. Trasenster, 1883, 586.

RAILWAYS, Portable, 1884, 126. *See* Portable Railways.

RAILWAY TRAFFIC, COST OF, *Paper* on the Cost of working different descriptions of Railway Traffic, by F. R. Conder, 1878, 184.—Division of revenue between passengers, goods, and minerals, unknown, 184.—Means of ascertaining it, 184.—"Train-mile" is the only unit for cost, 185.—Its disadvantages, 185.—True distribution of income and earnings first made for New South Wales Railways, 185.—Proper distribution of cost is proportionate to work actually done, 186.—Hauling of goods is more costly than of passenger trains, 187.—Cost of hauling per ton-mile is assumed equal at all speeds, 188.—Large increase in engineering expenses, where mineral traffic is

## RAILWAY TRAFFIC, COST OF (continued).

heavy, 188.—Average cost of passengers and goods per mile on French, American, Indian, and Australian railways, 188.—Engineering cost on English railways, as compared with proportion of gross revenue derived from mineral traffic, 189.—Average rate charged per ton of freight and per passenger is assumed equal, 191.—Net profit on goods and passenger traffic for 1875, 191.—Loss incurred by transport of mineral traffic, 191.—Need of new method for keeping railway accounts, 191.—Table of gross and net work on seven French railways, 192.—Ditto on seven Indian railways, 193.—Table of proportions to gross revenue borne by mineral receipts and by engineering cost, 194.

*Discussion.*—Williams, R. Price, Train-mileage principle is utterly fallacious, 195; tabular analysis of expenditure and receipts on five English railways, 196; table showing apportionment of working expenses on London and North Western Railway, 198; ditto on Great Northern Railway, 199; difference between expense of working passenger and goods traffic is much less than assumed by author, 200; cost of conveying coal is only a farthing per ton per mile, 201; tare weight of coal traffic is under 50 per cent. of gross weight of loaded train, 201; speed is a most important element in cost of haulage, 202.—Markham, C., Difficult to make a proper comparison between working expense of one railway and another, 203; gradients are a point that has not been noticed, 203; increased weight tends more to wear of rails than increased speed, 204; train-miles might be fictitiously augmented for special purposes, 205.—Ramsbottom, J., Impossible satisfactorily to compare working of different railways, 205; gradients may be worked more cheaply than levels, 206.—Robinson, J., Heavy traffic is generally worked down gradient, 206.—Cowper, E. A., Jars and jolts are greater at high than at low speed, 206.—Webb, F. W., Not advisable for railway companies to publish detailed accounts, 207.—Kershaw, J., Details of accounts are known to managers of railways, though not to public, 207; great expenses caused by heavy mineral traffic, 207; wear on descending side of gradients upon Great Northern Railway is perhaps due to heavy traffic being on that side, 208.—Webb, F. W., Heavy traffic on Great Northern Railway is not as a rule down-hill to London, 208.—Williams, R. P., Wear on descending track is quicker in all cases, 208.—Paget, A., Asked whether use of brakes might explain wear of rails, 209.—Williams, R. P., Brakes have little to do with extra wear, 209.—Paget, A., Facts appear all to be on the side of speed increasing the wear, 209.—Conder, F. R., Paper at least makes out a strong case for enquiry, 210.—Robinson, J., What items are included in "engineering expenses" on Metropolitan and North Eastern, 211.—Conder, F. R., "Engineering expenses" are maintenance, repairs, and

## RAILWAY TRAFFIC, COST OF (continued).

locomotion, 211.—Markham, C., Four other companies work over Metropolitan, 212.—Conder, F. R., Traffic on London and South Western Railway is altogether light, 213.—Robinson, J., Difficult for companies to obtain the cost of traffic, 214; several mineral lines pay high dividends, 214.—Williams, R. P., Will supply tables to be published in Proceedings, 214.—Conder, F. R., Purely mineral lines differ greatly from those with mixed traffic, 214.—Robinson, J., Hoped Mr. Price Williams would give a paper on tonnage and cost of conveying passengers and goods, 215.

RAILWAY WAGONS. *See* South-Wales Mineral Wagons, 1884, 415.

RAILWAY WORKING, *Paper* on the Economy of Railway Working, by R. Price Williams, 1879, 96.—Particulars needed to arrive at exact cost of any particular branch of railway working, 96.—Apportionment of various items of expense, 96.—Permanent way expenses, 97.—Large saving effected by use of steel rails, 100.—Comparative life of iron rails and steel rails, 100.—Locomotive expenses, 102.—Carriage and wagon repairs, 105.—Traffic expenses, 105.—Receipts and expenses in 1877 on railways north of Thames, 106.—Ditto on railways south of Thames, 107.—Goods and mineral traffic, comparison of tonnage and receipts, 111.—Goods and mineral receipts and expenses per train mile, 112.—Extra cost of haulage on ascending gradients, 112.—Appendix, Tabular statements, 116.

*Discussion.*—Williams, R. P., In reply to Mr. Conder's paper 1878, goods and mineral traffic is not carried on at a dead loss, but is the most paying traffic, 135; locomotive expenses as apportioned to passenger and to goods and mineral traffic, 136; ratio of receipts and expenses on various classes of railway, 136; explanation of diagrams, 138.—Conder, F. R., Author admits that accounts of railway companies do not suffice for ascertaining the cost of separate kinds of traffic, 142; speed at which train weight is carried does not affect wear of the line, 142; average speed of coal trains given too high, 143; no ground for such a term as "speed tons," 143; that mineral traffic is not lucrative is shown by decline in earning power of mineral lines, 144.—Galton, D., Main difficulty in such analysis is to get a proper apportionment, 144; speed not the only cause of wear of rails, 144; proportion between receipts and working expenses is declining, 145; third-class traffic requires to be more fully developed, 145.—Bergeron, C., Small branch railways could be worked cheaper by small than by great companies, 146; expenditure and receipts of Tréport railway, 147.—Williams, R. P., Speed of coal trains is actual average on Great Northern Railway, 148; actual facts showing effect of speed on wear of rails, 148; even if speed be not an element in wear and tear, goods and mineral traffic shows large profit, 149; general use of steel instead of iron rails would diminish



## RAILWAY WORKING (continued).

increase in working expense, 149; large proportionate profit on third-class traffic, 150.—Bergeron, C., Express trains in France entirely first-class, 151.—Galton, D., Great reduction in cost of locomotive power on Great Northern railway from 1873 to 1877, 151.—Williams, R. P., Reduction attributable to cheaper fuel and to greater economy in working, 151; easy gradients most important in constructing new lines, 151.—Robinson, J., First-class carriages on Continent are always full, but not in England, 152; reduction in rates might be most conveniently made on goods traffic, 152.

RAINFORD, A., elected, Member, 1875, 189.

RAISING OF WRECK "EDITH," *Paper* on the appliances and operations for Raising the wreck "Edith" at Holyhead, by L. M. Kortright, 1878, 116.—Position of wreck, 116.—Weight of wreck when submerged, 117.—Strength of ship calculated as girder, 117.—Description of lifting apparatus, 119.—Arrangement of timber staying to resist collapse, 122.—Operations at wreck, 123.—Tests of hooks for wire-rope attachments, 125.

*Discussion.*—Robinson, J., Importance of knowing best means of raising wrecks, 127.—Kortright, L. M., Subsequent operations for bringing ship into dry dock, 127.—Olrick, L., Machinery all designed by Mr. Halpin, 129.—West, H. H., Apparatus appears similar to that used by Mr. Harland, 129.—Halpin, D., Idea of fixing the tanks together with balks is Mr. Harland's, 129.—Robinson, J., More important to consider whether the mechanical appliances were the best that could be adopted, 130.—Gorman, W. A., Experience with the "Edith" shows how difficult it would be to raise the "Vanguard," 130; proposed apparatus for raising the "Eurydice," 130; design of a pontoon lifting-apparatus, 130.—Paget, A., Amount of "suck" that had to be overcome, 131.—Hayter, H., Conditions of the "Edith" and of the "Vanguard" are totally different, 132; no operation would be successful in raising the "Vanguard," 132.—Gray, J. M., Apparatus used for raising the "Edith" is much improved over that used by Mr. Harland, 133.—Webb, F. W., pontoons are now used for storage of water, 134; work was done under many difficulties, 135; system adopted for lifting was right, 135; very little repairs required to engines of "Edith," 135.—Cowper, E. A., Means of preventing ship from being held down by mud, 136.—Paget, A., Cheaper way would be to provide extra buoyancy, 136.—Webb, F. W., Extra immersion of pontoons was because of mud in hull, 136.—Halpin, D., Freeboard altered when coming in shore, 136; no suck whatever experienced, 137; difficulty of working with divers at depth in which "Vanguard" lies, 137; presence of sand improbable, 137.

RAIT, H. M., elected Member, 1878, 107.

- RAKE, H., elected Member, 1874, 27.
- RAMSBOTTOM, J., Brake, Automatic Screw-Brake, 1882, 509, 510.  
 Centrifugal Separator, 1882, 527.  
 Gas Engine, Atmospheric, 1875, 208, 209.  
 Hydraulic Machinery, Marine, 1874, 54.  
 Hydraulic Machinery, Workshop, 1874, 185.  
 Locomotives, Francq's Fireless, for Tramways, 1879, 628.  
 Locomotives, Fuel Consumption, 1884, 102.  
 Portable Railways, 1884, 145.  
 Railway Traffic, Cost of, 1878, 206.  
 Steel, Fluid-Compressed, and Guns, 1875, 283.  
 Ventilators for Mines, Mechanical, 1875, 532.
- RAMSDEN, SIR J., elected Member of Council, 1881, 30.—1884, 21.  
 Docks, Barrow-in-Furness, 1880, 331.
- RAMSDEN, R., elected Member, 1878, 31.
- RANKEILOR, W. C., elected Graduate, 1874, 101.
- RAPIER, R. C., Rules, 1877, 37.  
 Tramways, Permanent Way, 1880, 206, 210, 211.
- RATHBONE, E. P., elected Member, 1883, 309.  
 Collieries visited at Liège, Notes on, 1883, 528.  
 Railway, St. Gothard, 1883, 492.  
 Silver Ore Amalgamation, *Paper* on the Francke "Tina" or Vat Process  
 for the Amalgamation of Silver Ores, 1884, 257 —Remarks, 270.
- RATLIFFE, G., Forging of Crank Shafts, 1879, 475.
- RAYENHILL, J. R., Boiler and Engine, High-Pressure, 1877, 128.  
 Council, Annual Report, 1879, 34.  
 Patent Laws, 1876, 179, 185, 195.  
 Rules, 1879, 43.
- RAWLINSON, R., elected Member, 1878, 31.
- RAYLEIGH, LORD, nominated Honorary Life Member, 1878, 564.  
 Electric Lighting, 1879, 253.
- RAZE, A., Description of the Ougrée Iron and Steel Works, 1883, 541.
- READER, R., elected Member, 1883, 593.
- REAPING MACHINES. *See* Harvesting Machinery.
- REAY, T. P., elected Member, 1882, 255.
- RECORDER, Moscrop Engine Recorder, 1884, 150. *See* Engine Recorder.
- REDDITCH NEEDLE WORKS, Messrs. Milward's, 1876, 341.
- REDPATH, F. R., elected Member, 1881, 164.
- REDUCER for Water Pressure, 1879, 423, 434. *See* Water Pressure.
- REED, A. H., elected Member, 1883, 33.
- REED, C. H., elected Member, 1881, 9.
- REES, W. D., elected Member, 1884, 199.
- REES, W. T., elected Member, 1884, 199.

REGULATORS for Water Pressure, Foulis', 1879, 423. Barton and West's, 434.

*See* Water Pressure.

REID, J., elected Member, 1883, 593.

REMOVAL OF INSTITUTION to London, 1876, 29.—1877, 26, 163, 168. *See* Rules.

RENDER, F., elected Associate, 1877, 166.

RENNIE, G. B., elected Member of Council, 1878, 29.—1881, 30.—Vice-President, 1882, 32.

Blast-Furnace Working, 1883, 135, 154.

Docks, Pumping Machinery, *Paper* on the Pumping Machinery for emptying the Dry Docks at Chatham, and at Rio de Janeiro, 1874, 145.—Remarks, 157, 158, 159, 160.

Docks, Barrow-in-Furness, 1880, 331.

Exhibition, *Report* on the North-East Coast Exhibition of Marine Engineering &c., 1882, 472.

Petroleum Fuel in Locomotives, 1884, 302.

Shafting, Strength of, 1883, 210.

Steel, Fluid-Compressed, and Guns, 1875, 289.

Tunnel, St. Gothard, 1883, 176.

RENNIE, J., elected Member, 1878, 107.

RENNIE, J. K., elected Member, 1879, 398.

RENNOLDSON, J. M., elected Member, 1881, 164.

REPORT OF COUNCIL, Annual. *See* Council, Annual Report.

RESEARCH, MECHANICAL, 1879, 47.—Robinson, J., Suggestions as to subjects, 47; resolution proposed that £300 be voted, 47.—Hulse, W. W., Committee should be appointed from outside the Council, 47.—Robinson, J., Not proposed that Committee should consist of Council alone, 47.—Hulse, W. W., Amendment that the expenditure should be for promoting text books on science, 48.—Adamson, D., Better to expend money on premiums for papers than on research, 48.—Tweddell, R. H., Institution takes no responsibility in publishing results of experiments, 49.—Robinson, J., Heads of proposed scheme of Research, 49.—Resolution agreed to, 51.

Procedure in 1879, 1880, 12.—Expenditure, 16.—Vote of thanks to Research Committees and to Honorary Reporters, 23.—Riveted Joints, 186.

Progress in 1881, 1882, 19.—Riveted Joints, 31.—Steel, 37.

RESERVOIR DAM, La Gileppe, 1883, 516, 553.

RESTLER, J. W., elected Member, 1876, 347.

REUNERT, T., elected Member, 1883, 33.

REVERSING GEAR, HYDRAULIC, for Marine Engines, 1874, 35.

REYNOLDS, E., Gas Engine, Atmospheric, 1875, 204.

Engines, Winding, Direct-Acting, 1875, 233.

Forging of Crank Shafts, 1879, 473.

Marine Engine, 1881, 499.

Pump, Helical, 1874, 292.

REYNOLDS, E. (continued).

Shafting, Strength of, 1883, 213, 223.

Steam-ship "City of Rome," 1880, 346, 349, 357.

Steel, Fluid-Compressed, and Guns, 1875, 299.

Valve-Gear, Joy's, 1880, 445.

Wood-Working Machinery, 1875, 263.

REYNOLDS, G. B., elected Member, 1879, 583.

REYNOLDS, O., Screw Propeller, 1879, 604, 605, 608.

REYNOLDS, T. B., elected Graduate, 1884, 2.

RHODES, V., elected Member, 1882, 255.

RHYMNEY IRON WORKS, visited at Summer meeting, Cardiff, 1884, 359, 381-386.

RICH, W. E., elected Member, 1875, 315.

Dynamometer, Marine-Engine, 1877, 264.

Dynamometers, *Paper* on Dynamometers, Friction Brakes, and other testing apparatus belonging to the Royal Agricultural Society, 1876, 199.—Remarks, 227, 234, 239.

Expansion, Variable Automatic, 1877, 287.

Feed-Water Heater and Filter, 1881, 547.

Friction Experiments, 1884, 34.

Harvesting Machinery, 1881, 53.

Lead Processes, 1881, 536.

Lifts, Hydraulic, 1882, 162.

Locomotives, Compound, 1883, 447.

Locomotives, Fuel Consumption, 1884, 115.

Marine Engine, 1881, 489.

Power Transmission, 1881, 98.

Secretary, appointment, 1884, 78.

Thrashing Machines, 1881, 398, 400.

Tynewydd Colliery Inundation, 1877, 229.

Water Meters, 1882, 76.

RICHARDS, E. W., elected Member of Council, 1882, 32.

Blast-Furnace Working, 1882, 304, 310, 312.

Steel Compression by Steam, 1880, 400, 403, 415.

RICHARDS, G., elected Member, 1882, 476.

RICHARDS, L., elected Member, 1884, 409.

RICHARDSON, G., elected Member, 1881, 624.—Memoir, 1884, 474.

RICHARDSON, J., Hydraulic Machinery, Workshop, 1874, 191, 194.

RICHARDSON, W., elected Member of Council, 1877, 25.—1879, 36.—1882, 32.

Accidents, Mine, Mechanical Appliances for, 1877, 340.

Drilling Machines for Boiler Work, 1878, 581.

Engine Recorder, 1884, 160.

Feed-Water Heater and Filter, 1881, 546.

RICHARDSON, W. (continued).

High-Pressure Vessels, 1878, 290.

Locomotives, Francq's Fireless, for Tramways, 1879, 634.

Rope Gearing, 1876, 395.

Valves, Safety, 1877, 188.

Ventilator, Roots' Mine, 1877, 109.

RICHES, C. H., elected Member, 1884, 199.

Locomotive Running Shed, *Paper* on the new Locomotive Running Shed of the Taff Vale Railway at Cathays, Cardiff, 1884, 243.—Remarks, 254.

RICHES, T. H., elected Member, 1874, 101.

Accidents, Mine, Mechanical Appliances for, 1877, 329, 339.

Brakes, *Paper* on Automatic action in continuous railway Brakes, 1880, 100.—Remarks, 139-150.

Brake, Automatic Screw-Brake, 1882, 514.

Brakes, Effect of, upon railway trains, 1879, 204, 215.

Locomotive Running Shed, 1884, 250, 252.

South-Wales Mineral Wagons, 1884, 426.

Tynewydd Colliery Inundation, *Paper* on the Tynewydd Colliery Inundation, with particulars of the appliances used for rescuing the miners and recovering the workings, 1877, 221.—Remarks, 227, 232.

Vote of thanks, reply to, 1884, 201.

RICKETTS, F. H., elected Member, 1874, 256.—Decease, 1875, 3.—Memoir, 30.

RIDEHALGH, G. J. M., elected Associate, 1882, 16.

RIDLEY, J. C., elected Member, 1879, 398.

RILEY, J., elected Member, 1874, 256.

RIPPER, W., elected Associate, 1884, 80.

RIVER BENDS, Flow of Water round, 1879, 456. *See* Flow.

RIVET HOLES, advantages of drilled, 1876, 71, 96, 97, 110.

RIVET HOLES, punched and drilled, 1878, 222, 229. *See* Steel Boiler Experiments.

RIVET IRON AND STEEL, Tests of, 1879, 268. *See* Iron and Steel for Boilers.

RIVETED JOINTS, Tests of, 1879, 274. *See* Iron and Steel for Boilers.

RIVETED JOINTS. *See* Riveting.

RIVETING, *Paper* on Riveting, with special reference to Ship-Work, by M. Le Baron G. Clauzel, 1881, 167.—Fundamental principle in riveting, 168.—General formulæ, 169.—Practical formulæ, 173.—Application of practical formulæ, 177.—Width of joints, 183.—Butt joints, 184.—Proportion of strength, 185.—Narrowing towards edge, 186.—Diameter of rivets, 187.—Determination of constants, 188.—Diameter of rivets, 189.—Pitch, 190.—Calculation for joint with maximum strength, 191.—Joint with given proportion of strength, 194.—Keelson joints, with water-tight frame-plates, 196.—Weakening of plates at points of attachment, 197.—Strengthening-plates for shell plating, 199.—Riveting of corner angle-



## RIVETING (continued).

irons, 200.—Influence of corrosion, 201.—Reduction in width, 201.—  
Tabulated summary of formulæ, 203.

RIVETING, *Paper* on results of experiments on Riveted Joints, Series I—VIII made for the Institution of Mechanical Engineers, by A. B. W. Kennedy, 1881, 205.—Materials, preparation, and testing of specimens, 205.—Tenacity of plates, 206.—Elasticity, 208.—Tenacity of rivet steel, 213.—Shearing strength of rivet steel, 214.—Punching and drilling, 215.—Tension, shear, and bearing pressure, 219.—Margin and pitch, 222.—Final series of experiments on riveted joints, 224.—General results, 229.—Tabulated details of experiments, Tables I—XXV, 232–256.—Note respecting pitch and diameter of rivets, 257.

*Discussion.*—Kennedy, A. B. W., Experiments on shearing of actual rivets in plates, 258.—Tweddell, R. H., Rules of practice for riveted joints in iron, 258; elastic life of iron or steel, 259; limit of fatigue, 259; margin and pitch, 260.—Webb, F. W., Caulking and sponging of riveted joints, 260; internal corrosion in iron cattle-ships, 261; wider angle-irons for locomotive boilers, 261; failure of *Livadia's* boiler-plates, 262; treatment of steel plates for boilers, 263.—Boyd, W., Early set of steel in testing, 263; increased strength of steel after punching or drilling, 264.—Cowper, E. A., Early permanent set in iron tie-rods, 264.—Traill, T. W., Uniform width and length desirable for test specimens, 264; elastic limit should be beginning of set, 265; experimental shearing results are much higher than in actual joints, 265; measurement of diameter of rivet holes, 265.—Longridge, R. C., High proportional strength of steel joints as compared with iron, 266; increase of strength due to perforation of plates, 267; natural tenacity of plates, 267.—Cowper, E. A., Reduced area of section at point of fracture, 268.—Longridge, R. C., Perforation equalises intensity of strain, 268.—Schönheyder, W., Objection to mode of testing for shearing, 268.—Hall, W. S., Experiments and practice coincide tolerably as to pitch, but not as to diameter, 269; weakening of joints by corrosion, 269.—Head, Jeremiah, Early commencement of permanent set, 269; joints are tested straight in experiments, but are curved in many structures, 270; evil of bending cold after punching, 270.—John, W., Elastic curve of iron as compared with steel, 271; effect of punching on thin and thick plates, 272; difference between testing a narrow strip and a wide plate, 273.—Halpin, D., Difference between limit of tensile strength and actual breaking stress, 273.—Fletcher, L. E., Particulars of hydraulic bursting tests on experimental boiler, 274; strength of test strips, 275; comparison between hydraulic bursting and machine tests, 276; strength of single-riveted lap-joint, 276; greater strength of joints in boiler than in test strips, 276; punched plates really stronger than plain plates, 277; 3-in.

## RIVETING (continued).

pitch of rivets sufficient for tightness, 277; cracking of plates at inner edge of lap joints, 278.—Beaumont, W. W., Minuteness of early permanent set, 278.—Schönheyder, W., Rivets pitched wide longitudinally may have narrow pitch diagonally, 279.—Fletcher, L. E., Wider pitch and larger rivets would make stronger joint, 279.—Head, Jeremiah, Effect of large or small hole in bolster, 279.—Fletcher, L. E., Punched plates stretched less than solid plates, 280; tabulated results of tests on punched plates, 280.—Cowper, E. A., Very little apparent difference between large bolster and small, 280.—Cowper, C. E., Enquired effect of narrowing test strips to a waist, 280.—Fletcher, L. E., Narrowing would give better result, 282.—Cowper, E. A., Confirmation from experiment, 282.—Willis, R. H., Experiments on tenacity of screwed bolts, 282.—Unwin, W. C., Size of specimens has very little influence on results, 283; gain of strength in drilled and punched plates, 283; probably due to diminished contraction of area, 284; bearing pressure may be neglected in designing riveted joints, 285.—Cowper, E. A., Early commencement of permanent set not serious, 285; injury to boiler plates by bending, 285; smallness of friction in shearing apparatus, 286; testing machines at Barrow Steel Works and at University College, 286; measurement of extensions by reflection from mirror, 286.—Kennedy, A. B. W., Difference between results with steel joints, and actual proportions of iron joints, 287; chief inferences from experiments, 287; single-riveted joint in thick steel plate will be no stronger than in iron, 288; very early commencement of permanent set, 288; difference between ordinary iron boiler-plate and mild steel, 289; friction in shearing apparatus for rivets, 289; modulus of elasticity is constant under varying strains, 290; correspondence between permanent set in steel and in very ductile iron, 290; determination of limit of elasticity, 290; difference in fractured areas is not cause of difference between perforated and unperforated plates, 291.

RIVETING, *Table* showing rules of practice used by various manufacturers for Iron Riveted Joints, compiled by R. H. Tweddell, 1881, 293–299.—Single-riveted lap-joints, 293–295.—Double-riveted lap-joints, 296–299.

RIVETING, *First Report* to the Council of the Committee on the form of Riveted Joints, W. C. Unwin reporter, 1881, 301.—Table of contents, 301.—Reporter's preface, 302.—List of memoirs consulted, 303.—History of experiments on riveting, 305.—Straining action on riveted joints, 317.—Apparent tenacity of material, 318.—Tenacity of iron and steel plates, 321.—Apparent tenacity of punched and drilled plates, 321.—Apparent tenacity of annealed and rimmed plates, 325.—Apparent shearing resistance of rivet iron and steel, 325.—Friction of riveted plates, 327.—Pressure on bearing surface of rivet, 329.—Pin connections, 333.—Diameter

## RIVETING (continued).

of rivets, 334.—Overlap, and distance from rivet to edge, 336.—Experiments on riveted joints, 338.—Single-riveted lap-joints of iron, 339.—Single-riveted butt-joints of iron, 343.—Double-riveted lap and butt joints of iron, 345.—Shearing resistance of iron and steel rivets in steel plates, 348.—Tearing resistance of steel lap-joints, 351.—Tearing resistance of steel butt joints, 355.—Appendix I, bending action on thick plates in joints, 357.—Appendix II, suggestions for experiments on riveted joints, 360; tenacity of plates, 361; shearing resistance of rivet steel, 362; precautions suggested by previous experiments, 362; influence of mode of making rivet holes, 363; influence of crushing pressure, 365; influence of bending action, 367.

RIVETING, *Report on further experiments on Riveted Joints, Series IX*, by A. B. W. Kennedy, 1881, 712.—Description of  $\frac{3}{4}$ -in. steel joints, 712.—Summary of results of testing, 713.—Joints cut across the plates, 715.—Slipping in testing, 715.—Different proportions necessary for iron and steel joints, 716.—Impossible to break steel joints in boilers, 716.—Results of experiments, Tables XXVI and XXVII, 717-719.

RIVETING, *Memorandum of experiments on Lap-Joints, with Rivets of different sizes*, by R. V. J. Knight, 1881, 720.

RIVETING, Results of experimental research in 1881 upon Riveted Joints, 1882, 19.—Remarks on ditto by E. A. Cowper, 31.

RIVETING, *Report of experiments on Riveted Joints with high bearing pressures, Series X*, by A. B. W. Kennedy, 1882, 138.—Object of experiments, 138.—Testing of  $\frac{1}{4}$ -in. steel joints, 139.—Testing of  $\frac{3}{8}$ -in. steel joints, 140.—Slipping of joints at very low loads, 141.—Conclusions, 141.—Practical limit for bearing pressure, 142.—Results of experiments, Table XXVIII, 143.

RIVETING, HYDRAULIC, 1874, 166, 167, 168, 176, 179, 191, 201.

RIVETING MACHINES, STEAM, Tweddell's Hydraulic, MacColl's Power, 1879, 271.

*See Iron and Steel for Boilers.*

RIVETS, Steel, 1878, 223, 230. *See Steel Boiler Experiments.*

RIXOM, A. J., elected Member, 1879, 398.

ROANHEAD IRON MINE, visited at Barrow meeting, 1880, 485.

ROATH DOCK, Cardiff, 1884, 227.

ROBERTS, T. H., elected Member, 1879, 398.

ROBERTS, W. CHANDLER, Iron and Steel, Physical condition of, 1884, 55.

Steel, Hardening &c., *Memorandum on results of experiments on Steel, with reference to Occluded Gases*, 1881, 706.

Zinc Manufacture in Belgium, 1883, 364.

ROBERTSON, D., elected Member, 1879, 398.

ROBERTSON, W., elected Member, 1879, 583.

ROBINS, E., elected Member, 1883, 33.

ROBINSON, H., elected Member, 1874, 256.

Compressed-Air Machinery, 1874, 217.

ROBINSON, J., elected Vice-President, 1874, 26.—1875, 34.—1876, 26.—Member of Council, 1877, 25.—President, 1878, 28.—1879, 36.

Accidents, Mine, Mechanical Appliances for, 1877, 336.

Addresses, Presidential, 1878, 295.—1879, 399.

Armour, Construction of, 1879, 69, 73, 83.

Axlebox, Radial, 1877, 309.

Board of Trade, resolution respecting action of, 1878, 563.

Boiler, Lancashire, 1876, 114.

Brakes, Automatic Action, 1880, 150.

Brakes, Continuous, for railway trains, 1878, 99, 105.

Brakes, Effect of, upon railway trains, 1878, 479, 488, 489, 616, 631.—1879, 51, 217.

Chuck, Electro-Magnetic, 1875, 42.

Constitution of Institution, 1878, 41, 42.—Incorporation of, 1878, 557.

Council, Annual Report, 1879, 34.—1880, 23.

Cutting of Metals, 1883, 259.

Disintegrator, Vapart, 1878, 503.

Dock, Victoria Floating, 1878, 182.

Dredger, Vertical-action, 1879, 562.

Drilling Machines for Boiler Work, 1878, 588.

Electric Lighting, 1878, 544.—1879, 264.

Expansion Gear, Correy, 1878, 523, 527.

Flow of Solids, 1878, 328.

Forging of Crank Shafts, 1879, 481.

Friction Experiments, 1883, 654.

Gauge, Railway, 1875, 85.

Glasgow meeting, reply to Lord Provost's welcome, 1879, 397.

Governors, 1879, 421.

Heslop Engine, 1879, 94, 95.

Hydraulic Machinery, Toulon, 1878, 377, 378, 379, 381, 382, 385, 386.

Injector, Automatic, 1884, 171.

Iron and Steel for Boilers, 1879, 326.

Library, 1878, 564.—1879, 34.

Locomotives, Compound, 1879, 363.

Locomotives, Francq's Fireless, for Tramways, 1879, 639.

Locomotives, Fuel Consumption, 1884, 103, 110, 116.

Members, Honorary Life, 1878, 564.—Life, 1879, 41, 43, 46.

Paris Exhibition, 1878, 557.

Penn, decease of Mr. Penn, 1878, 557.

## ROBINSON, J. (continued).

- Power Transmission by Ropes, 1874, 68.  
 Premiums and Diplomas, 1878, 44.  
 President, on election as, 1878, 32, 34.—*Addresses*, 1878, 295; 1879, 399.  
 —On retiring, 1880, 25, 27. On President's address, 1880, 322. On President's illness, 1884, 411.  
 Pressure-Intensifying Apparatus, 1878, 55, 60, 65.  
 Proceedings, purchase of, 1879, 156.  
 Pump, Greindl Rotary, 1878, 465.  
 Railway Traffic, Cost of, 1878, 206, 211, 213, 215.  
 Railway Working, Economy of, 1879, 151.  
 Raising of wreck "Edith," 1878, 127, 130.  
 Research, Mechanical, 1878, 563.—1879, 47, 49.  
 Rules, 1874, 29, 257.—1875, 36.—1877, 36.—1878, 560.—1879, 40.—1880, 33, 35.—1884, 412.  
 Safety Lamps, 1879, 237.  
 Screw Propellers, 1879, 609.  
 Secretary, Vote to late, 1878, 108, 112.—Appointment of, 1884, 78.  
 Steam-ship "City of Rome," 1880, 351, 355.  
 Steel Boiler Experiments, 1878, 267, 270.  
 Steel, Chernoff's papers, 1880, 238, 239, 243.  
 Tramways, Mechanical Traction, 1878, 423, 425, 426.  
 Tramways, Permanent Way, 1880, 208, 219.  
 Transport, *Presidential Address* on cheap internal transport, 1879, 399.  
 Treasurer, appointment of new, and services of late, 1878, 560.  
 Valve-Gear, Joy's, 1880, 439.  
 Water Meter, Barton and West's, 1879, 454, 455.  
 Water-Power Engines, 1879, 493.  
 Water-Pressure Regulators, 1879, 443.  
 ROBINSON, J. (Rochdale), decease, 1878, 21.—Memoir, 13.  
 ROBINSON, J. F., elected Member, 1878, 293.  
 ROBINSON, J. S., elected Member, 1876, 28.  
 ROBINSON, T. N., elected Member, 1878, 31.

Wood-Working Machinery, *Paper* on Wood-Working Machinery, 1875, 248. —Remarks, 258, 265, 266.

ROCK-DRILL, DIAMOND, *Paper* on Rock Boring by the Diamond Drill, and recent applications of the process, by Major Beaumont, 1875, 92.—Extreme hardness of diamond, 92.—Acts by abrasion, not by cutting. 93.—Black diamond or carbonate preferable to crystallised diamond for boring, 94.—Diamond much more effective than steel tools for boring rocks, 94.—Construction of diamond boring tools, 95.—Means of applying pressure upon drill, 96.—Prospecting machines for putting down exploring holes,



## ROCK-DRILL. DIAMOND (continued).

96.—Speed and depths of boring effected, 98.—Tunnel-driving machine, 100.—Shaft-sinking machinery, 101.—Application to driving headings, 102.—Comparison of diamond drill and percussive drills, 103.—Special advantage of diamond drill in shaft-sinking, 103.—Subaqueous boring machinery, 104.—Results of working, 105.—Arrangement for putting down large bore-holes in deep water, 106.

*Discussion.* — Beaumont, Major, Proposed use of diamond drill for removing Daunt's rock, 108.—Homersham, S. C., Boring at Middlesbrough through rock salt with percussive drill, 109.—Cochrane, C., Difficulties in piercing pebble bed with diamond drill, 111.—Shoolbred, J. N., Tunnel-driving with percussive drill at Severn Tunnel, 111.—Cowper, E. A., Difficulties in passing through soft or soluble strata, 112.—Siemens, C. W., Action of diamond by absolute crushing with very great pressure, 112.—Thornycroft, J. T., Difficulties in loose strata could probably be overcome by use of lining tube, 113.—Tweddell, R. H., Pressure upon drill, 113.—Beaumont, Major, Percussive boring machine, 113; diamond drill superior for speed and for evidence of the strata, 115; special means of boring through pebble beds, 117; special undercutting tool, 117; special lining tubes, 118; speed of boring with diamond drill in hard limestone, 118; diamond drill better than percussive drill for deep boring, but not for moderate depths, 118; lining tubes for boring through soft strata, 119; high speed of drill under low pressure not found to answer, 120; means of withdrawing core from bore-hole, 121.—Siemens, C. W., Pressure on diamond per square inch, 122; black diamond extremely hard and tough, 123.—Appleby, C. J., Experiments on very high speed of drill, 123.—Bramwell, F. J., Great progress made in application of diamond drill, 124; best boring tool for great depths, and for obtaining cores of the rock bored through, 124; diamond tool used successfully for dressing millstones, 125.

ROCK-DRILLING MACHINERY, *Paper on Rock-Drilling Machinery*, by T. B. Jordan, 1874, 77.—Requisites for rock-drilling machines, 77.—Sachs rock drill used in Germany, 77.—Complicated construction of drilling machines, 78.—Darlington's rock drill, 79.—Piston made to do the work of a valve, 80.—Contrivance for rotating the drill, 81.—Piston without any packing, 81.—Method of fixing the tool, 82.—Means of advancing the drill, 83.—Jordan's stand for fixing the machine, 83.—Stand easily moved and refixed, 84.—Saving of time effected by mechanical drilling, 85.—Use of dynamite, 85.—Arrangement of drilling machine for sinking large shafts, 85.—Machines for compressing air, different constructions, 86.—Direct pressure of column of water, 86.—Compressing piston with water chamber at each end of cylinder, 87.—Dry cylinder and piston, 87.—Water-jacketed

## ROCK-DRILLING MACHINERY (continued).

compressing pump with injection of water, 88.—Jordan's air-compressing pump, 88.—Advantages of mechanical power in mining operations underground, 89.—Result of Sachs machines working at Mechernich, 90.—Comparative cost of hand labour, 91.—Saving in cost of machine work, 91.—Advantages in shortening time of sinking shafts, 91.

*Discussion.*—Taylor, J., Use of Darlington's rock drill for mining operations, 92; dynamite used in mines in Portugal, 93; peculiar effect of dynamite, force of explosion expended downwards, 93.—Thomas, J. L., Holes required to be bored in any direction for taking advantage of jointing in rock, 93.—Coode, Sir J., Perfection of rotating arrangement for drill very important, other machines found not satisfactory in rotation, 93; hole liable to become polygonal from defect in rotation of drill, 94.—Jordan, T. B., Means for rotating drill in Darlington's machine, 94.—Westmacott, P. G. B., Difficulty experienced with Penrice's machine from breaking of edge of tool, and abrasion of sides, 95; difficulty removed by holding tool against rock and then striking end of tool, as in hand work, 95.—Tweddell, R. H., Efficiency of air-compressing pump affected by high temperature, 95.—Bramwell, F. J., Air taken by compressing pump should be as cold as possible, 96.—Welch, E. J. C., Method of rendering piston air-tight without packing, 96.—Jordan, T. B., Speed of drilling holes in granite, 96; Sachs drilling machine, details of construction, large number of separate parts requisite for working the valve, 97; in Darlington's machine, only two parts requisite for reciprocating action, 98.—Bramwell, F. J., Great value of appliances for increasing the rate of advance of mining work, whether saving in cost or not, 99; Darlington's drill likely also to effect great saving in cost, 99; important advance made in last ten years, from Mont Cenis tunnel machine in 1864, 99.

ROCK-DRILLING MACHINERY, *Paper on the Mechanical Appliances used in the construction of the heading under the Severn for the Severn Tunnel Railway.* by J. J. Geach, 1877, 206.—Sounding apparatus for tunnel works, 206.—Sinking of the first shaft, 208.—Rock-drilling machine, 208.—Particulars of working, 208.—Means of fixing drill in piston-rod, 210.—Comparison of automatic and hand gear for actuating the valve, 211.—Results of working, 211.—Rock-drill carriage, 212.—Air-compressors, 213.—Injection of water into air cylinders, 214.—Pumping machinery for water, 215.

*Discussion.*—Geach, J. J., Speed of drilling, 216.—Froude, W., Quality and hardness of steel for drills, 217.—Geach, J. J., Quality and temper of drills, 217.—Hawksley, T., Hardness of rock encountered, 217.—Morgaus, T., Pressure of compressed air obtained, 217.—Cowper, E. A., Speed of rock-drilling machines, 217.—Geach, J. J., Action of air-compressor,

## ROCK-DRILLING MACHINERY (continued).

218; electric firing not successful, 218; number of strokes of drill per minute varies, 219; machine is rather a jumping than a drilling machine, 219.

ROCOUR, G., Zinc Manufacture in Belgium, 1883, 362, 366.

RODGER, W., elected Member, 1879, 398.

RODRIGUES, J. M. DE C., elected Member, 1884, 2.

ROECKNER, C. H., elected Associate, 1878, 31.

ROGERS, P. P., elected Graduate, 1881, 164.

ROGERSON, J., Marine Engine, 1881, 485.

Ships, Iron and Steel for, 1881, 562.

ROLFE, C. S., elected Member, 1878, 107.

ROLLING MACHINERY for Plates, 1880, 82. *See* Plate Rolling Machinery.

RONAYNE, J. P., decease, 1877, 3.—Mémorial, 21.

ROOTS' MINE VENTILATOR, 1877, 92. *See* Ventilator, Roots' Mine.

ROPE GEARING, *Paper* on Rope Gearing for the Transmission of large Power in mills and factories, by J. Durie, 1876, 372.—Leather belts adopted for transmitting large power in America, 372.—Rope gearing given complete satisfaction, 372.—Sizes of ropes employed, 373.—Right proportion between diameter of ropes and of pulleys, 373.—Mode of applying complete system of rope gearing, 373.—Power transmitted per rope, 374.—Form of groove, 374.—Advantage of having more than one rope for driving, 375.—Arrangement of rope gearing in Jute Factory, Calcutta, 375.—Means for substituting rope gearing in place of toothed gearing, 375.—Comparison between toothed gearing and rope gearing, 376.—Less friction of rope gearing, 377.—Advantage of rope over belt gearing, 378.—Comparative sizes of ropes and belts, 379.—Table of experiments on friction of ropes and leather belts, 381.

*Discussion.*—Welch, E. J. C., Required tension for ropes should be correctly ascertained, 382; most suitable angle for grooves in pulleys, 382; driving side of rope to be at bottom of pulleys, 383; comparison between rope and belt for same power, 383; formulæ for calculation, 383; results of calculation, 384.—Paget, A., Correct coefficient of friction not yet obtained, 388; best angle for grooves, 388.—Cowper, E. A., Determination of the power a pulley would transmit, 389; copper-wire band used for moderate power where temperature varied, 389; steel bands in place of leather belts, 390.—Clay, W., Hide band better than rope for travelling crane, 391; objection to driving rolling mills by rope, 391.—Musgrave, J., Mills at Calcutta driven by rope gearing, 391; original introduction at Belfast, 392.—Inglis, W., Rope gearing extensively used for driving works, 392.—Head, J., Rope gearing not applicable to rolling mills, 393.—Smith, W., Early employment of ropes for driving machinery, 393;

## ROPE GEARING (continued).

vibration of spur gearing avoided, 394; bearing of ropes in grooves, 394.  
 —Beeley, T., Satisfactory working of rope gearing in driving mills, 394.  
 —Hulse, W. W., Rope gearing largely used both in Ireland and this country, 395.—Richardson, W., Semicircular grooves best for ropes, 395; straps or ropes effect great saving for driving quick speeds in rolling mills, 396.—Cowper, E. A., Careful treatment of wire rope required for ensuring durability, 396.—Preston, F., Rope gearing considerably used for driving machinery, 397; power transmitted per rope, 397; no serious accidents with rope gearing, and great freedom from breakage, 398.—Musgrave, J., Form of grooves for pulleys, 398.—Durie, J., Difficulty of ascertaining correct coefficient of friction, 398; tension on rope in relation to its durability, 399; rolling mills driven by ropes, 399; form of rope groove found satisfactory, 399; splice in rope should not increase its diameter, 399.

ROPES, TRANSMISSION OF POWER BY. *See* Power Transmission by Ropes, 1874, 56.—Rope Gearing, 1876, 372.—Power Transmission, 1881, 57.

ROPES, tramways worked by, 1878, 399. *See* Tramways, Mechanical Traction.

ROPE WORKS, Cardiff, 1884, 365.

ROSE, T., decease, 1875, 3.—Memoir, 31.

ROSS, J. A. G., elected Member, 1874, 27.

Gauge, Standard, for High Pressures, 1880, 472.

Hydraulic Machinery, Toulon, 1878, 384, 385.

Tramways, Mechanical Traction, 1878, 428.

ROSS, T. B., elected Member, 1876, 57.—Decease, 1879, 22.—Memoir, 15.

ROSS, W., elected Member, 1881, 164.

ROSSIUS, M., Angleur Steel Works, Description of, 1883, 537.

ROTARY PUMPING ENGINE, beam, 1874, 259.—Horizontal geared, 260.

ROUND OAK IRON WORKS, 1876, 336.

ROUTH, W. P., elected Member, 1878, 31.

ROUTLEDGE, T., elected Member, 1880, 310.

Jute Machinery, 1880, 392.

ROUX, P. S., elected Graduate, 1884, 199.

ROWAN, D., Address of President, 1879, 404.

ROWAN, F. J., elected Member, 1878, 31.

ROYERS, G. A., Antwerp, Notes on the Trade of, 1883, 557.

Harbour Works, *Paper* on the new Harbour Works at Antwerp, 1883, 494.

RULES OF INSTITUTION, Alterations:—

Additional meetings, motion by A. Paget, 1877, 43.—*Discussion*, Welch, E. J. C., 43.—*Motion* carried, 43.

Alterations, various, 1879, 38.—1884, 26, 27. Additional Bye-Laws, 1879, 41.—1880, 31-36.

## RULES OF INSTITUTION, Alterations (continued).

Autumn meeting in Manchester, motion by J. Robinson, 1875, 36.—*Discussion*, Siemens, C. W., 37.—Paget, A., 37.—Bramwell, F. J., 37.—Wise, W. L., 37.—Motion carried, 37.

Dates for meetings, motion by A. Paget, 1876, 28.—*Discussion*, Chapman, H., 28.—Motion carried, 28.

Diagrams, Preparation of, motion by A. Paget, 1877, 45.—*Discussion*, Chapman, H., 46.—Robinson, J., 46.—Cowper, E. A., 46.—Paget, A., 46.—Hawksley, C., 46.—Bramwell, F. J., 47.—Paget, A., 47.—Motion withdrawn, 47.

Discussions, reopening of, motion by J. Head in absence of E. J. C. Welch, 1880, 33.—Robinson, J., Amendment to motion, 35.—Cochrane, C., Seconded ditto, 36.—Amendment carried, 36.

Hours for meetings, motion by A. Paget, 1877, 43.—*Discussion*, Fox, C. D., 43.—Motion carried, 43.

Introduction of friends to meetings, motion by A. Paget, 1877, 43.—*Discussion*, Webb, F. W., 44.—Siemens, C. W., 44.—Tomlinson, J., 44.—Motion carried, 44.

Life Membership, proposed new Bye-Law, 1879, 41.—Hulse, W. W., Fifteen year purchase for life membership should be reduced to ten, 41.—Robinson, J., Institution of Civil Engineers require sixteen years', 41.—Hulse, W. W., Purchase should be at a rate to make it acceptable, 42.—Williams, R. P., Purchase money should be value of reversion, 42.—Fletcher, H. A., Ten years' purchase has not induced many to become life members, 42.—Ravenhill, J. R., Average age of members when admitted, 43.—Robinson, J., No means of ascertaining this, 43.—Paget, A., Not desirable to offer life membership too cheap, 43; proper way to calculate payment at age of youngest member who could compound, 43.—Williams, R. P., Question is simply an actuarial one, 44.—Hawksley, T., Amendment that compounding be discontinued, 44.—Paget, A., Seconded amendment, 45.—Hulse, W. W., What objections to compounding, 45.—Hawksley, T., Impossible to take account of all circumstances, 45.—Robinson, J., Better not to have life members, 46.—Amendment carried, 46.

Meetings to be held in London, motion by A. Paget, 1874, 28.—*Discussion*, Jeffreys, E., 29.—Robinson, J., 29.—Brown, A. B., 30.—Wise, W. L., 30.—Lloyd, S., 30.—Paget, A., 30.—Siemens, C. W., 30.—Hulse, W. W., 31.—Bennett, P. D., 31.—Cowper, E. A., 31.—Walker, C. C., 31.—Hawksley, T., 32.—Paget, A., 32.—Cochrane, C., 32.—Motion carried, 32.

Membership, Certificates of, 1878, 44, 114, 562.

Notices of motions, 1875, 315.—1876, 349.—1877, 309, 302.—1878, 560, 562.—1879, 585, 587.—1883, 596.—1884, 412, 413.



## RULES OF INSTITUTION, Alterations (continued).

Opening of ballot papers, motion by A. Paget, 1876, 29.—*Discussion*.  
Bramwell, F. J., 29.—Motion carried, 29.

Papers, Reading of, motion by A. Paget, 1877, 44.—*Discussion*, Hawksley,  
T., 44.—Marshall, A., 44.—Motion carried, 44.

Papers, Premiums for, 1878, 43, 114, 564.

Papers, supply of preliminary copies of papers, and re-opening of discussions,  
motions by J. Head in absence of E. J. C. Welch, 1880, 33.—Head,  
Jeremiah, Moved motions for sake of discussion only, 33.—Paget, A.,  
Seconded motions for same reason, 33.—Robinson, J., Amendment 'to  
first motion, 33.—Crampton, T. R., Seconded ditto, 34.—Adamson, D.,  
Both motion and amendment undesirable, 34.—Cochrane, C., Amendment  
only confirms present practice, 34.—Tweddell, R. H., Supported Mr.  
Adamson, 35.—Hulse, W. W., Preliminary copies of papers might be sent  
to all members, 35.—Cowper, E. A., Proposal renders legal what is already  
done, 35.—Amendment carried, 35.—Robinson, J., Amendment to second  
motion, 35.—Cochrane, C., Seconded ditto, 36.—Amendment carried, 36.

Polling on challenged vote, and voting by proxy, 1878, 35.—Williams, R. P.,  
Resolution respecting polling on challenged vote, 35.—Paget, A.,  
Seconded resolution, 35.—Adamson, D., Amendment to allow of voting  
by proxy, 35.—Cowper, E. A., Members ought to have sufficient interest  
in Institution to attend personally, 36; mistake to be constantly altering  
the rules, 37.—Head, Jeremiah, Proxies give permission to stay away,  
37.—Crampton, T. R., Question of proxies requires to be quietly  
considered, 38.—Bell, I. L., Voting by proxy should not be admitted,  
38.—Menelaus, W., Alteration of rules should be made by members  
attending the meetings, 39.—Williams, R. P., Voting by proxy produces  
serious evils, 39; proposed rule is only contemplated to be brought into  
operation in emergencies, 40.—Adamson, D., Distant members should  
have power to entrust their vote to another member, 40.—Amendment  
lost, 40.—Resolution also lost, 40.

Removal of Institution to London, motion by A. Paget, 1876, 29.—  
*Discussion*, Platt, J., 29.—Wright, J., 29.—Wise, W. L., 30.—Siemens,  
C. W., 30.—Cowper, E. A., 30.—Bramwell, F. J., 30.—Head, J., 31.—  
Tweddell, R. H., 31.—Bennett, P. D., 31.—Cochrane, C., 31.—Paget, A.,  
31.—Hawksley, T., 32.—Motion withdrawn, 32.

Motion by C. Cochrane, 1877, 26.—*Discussion*, Carbutt, E. H.,  
Attendances at the country and the London meetings, 27; number of  
Members in different districts, 27; removal to London would greatly  
increase importance of Institution, 28; convenient railway access to  
London, 28.—Adams, W. A., Not a London but a country Institution, 29;  
objectionable to remove to London, 29.—Bennett, P. D., Essentially a

## RULES OF INSTITUTION, Alterations (continued).

national provincial Institution, 30; removal to London injurious, 30; advantage of being established in the provinces, 31.—Williams, R. Price, Institution would benefit by going to London, 32.—Bramwell, F. J., Not any advantage in removing seat of government to London, 32.—Plum, T. W., Locality of offices a matter of minor importance, 34.—Hulse, W. W., London the best place for Institution, 35.—Robinson, J., Objections to removal to London, 36.—Rapier, R. C., Most convenient and advisable to remove to London, 37.—Head, J., Offices of Institution should be in London, 38.—Cowper, E. A., Institution was not started as a provincial institution, 39; London the proper place for such an institution, 40.—Siemens, C. W., Enquiry into the question, 41; advantageous for Institution to be in London, 42.—Hawksley, T., Motion carried, 42.

Reports of discussions and papers read, 1875, 37.—1876, 32.—1877, 44.

Secretary, Bye-Law relating to, 1879, 39, 40.—Duties, 1884, 26.—Secretary to devote his whole time to Institution, 1884, 27.

Transference of Graduates or Associates to Members, 1880, 31.

Treasurership, alteration respecting, 1878, 34.—Bye-Law relating to, 1879, 39, 40.

RUMBLE, T. W., decease, 1884, 3.—Mémoir, 67.

RUNNING SHED, LOCOMOTIVE, 1884, 243. *See* Locomotive Running Shed.

RUSSELL, Hon. W., elected Member, 1878, 293.

RUSSELL's Tube Works, Wednesbury, 1876, 339.

RUTHERFORD, G., elected Member, 1884, 80.

RUTTER, E., elected Member, 1877, 165.

RYDER, G., elected Member, 1883, 310.

RYE, W., Engines, Winding, Direct-Acting, 1875, 235.

## S.

SACHS ROCK-DRILLING MACHINE, 1874, 77, 90, 97.

SACRÉ, C., Brakes, Effect of, upon railway trains, 1878, 621.

SACRÉ, E. A., decease, 1882, 17.—Mémoir, 11.

SADOINE, E., elected Member, 1883, 310.

Cockerill, Addresses of welcome to members visiting Works of the Society

Cockerill, 1883, 511, 512.—Description of Works, 519.

SAFETY LAMPS. *Paper* on the Construction and Comparative Merits of the Safety

Lamps generally in use, by A. C. Bagot, 1879, 219.—Davy lamp, 219.—

Clanny lamp, 221.—Stephenson lamp, 221.—Mueseler lamp, 222.—

## SAFETY LAMPS (continued).

Williamson lamp, 223.—Essential qualifications of a good safety lamp, 224.—Recent experiments on the stability of various safety lamps, 225.—Toughened glass unfit for safety lamps, 226.—Method to be adopted when the gas has fired inside the gauze, 227.—Means for testing lamps before supplying to the colliers, 228.

*Discussion.*—Hopkinson, J., Use of electric light in coal mines, 229.—Adamson, D., Safety lamp, though a simple instrument, is of great interest and importance to engineers, 229; danger of coal dust, 230; protection by gauze only is not complete, 230; proper method of managing lamp-room, 231.—Cowper, E. A., Explosive mixture of coal dust and air ought to be tried as an element of danger, 231.—Crampton, T. R., Best means of making cheap gas, 231.—Bagot, A. C., Objections to electric light for mines, 232; danger of miner carrying two lamps, 234; shield outside gauze is better than glass, 234; no fear of explosion from coal dust with ordinary care, 235; watering of dry collieries is very important, 235; cost and use of apparatus for testing gas, 235.—Webb, F. W., Very small spark of electricity will ignite gas, 236; bad results of toughened glass, 233.—Cowper, E. A., Coal dust might pass through gauze at white heat and cause explosion, 236; difficulty of getting electric light down a pit is not insuperable, 236.—Olrick, L., Lamp with portable reservoir of compressed air for preventing explosions, 237.—Robinson, J., Subject of great importance for saving of human life, 237.

SAFETY VALVES. *See* Valves, Safety, 1877, 176. *See also* 1876, 74, 102, 111.

SAMPSON, J. L., elected Member, 1874, 101.

SAMUEL, J., decease, 1875, 3.—Memoir, 31.

SAMUELSON, A., decease, 1874, 2.—Memoir, 24.

SAMUELSON, B., elected Member of Council, 1883, 53.

Coke Manufacture, 1883, 291.

SAMUELSON, E., elected Member, 1881, 164.

Harvesting Machinery, *Paper* on Harvesting Machinery, 1881, 34.—Remarks, 52, 54.

SANCHEZ, J. E., elected Graduate, 1882, 146.

SANDERS, H. C., elected Member, 1881, 409.

SANDERS, R. D., Brakes, *Paper* on Continuous Brakes for railway trains, 1878, 67.—Remarks, 81, 84, 100.

Brakes, Effect of, upon railway trains, 1879, 204.

Brakes, Automatic Action, 1880, 113–117.

SANDERS' AUTOMATIC VACUUM BRAKE, 1877, 298.

SANDHAM, H., elected Associate, 1883, 180.

SANDIFORD, C., elected Member, 1881, 9.

SAND PUMP, for sinking mine shafts through sand.—Gill's, 1880, 485.—Mather and Platt's, 1880, 485, 487.

SANDSCALE MINING Co.'s new sinking, visited at Barrow meeting, 1880, 485.

SANDWELL COLLIERY, 1876, 330.—1882, 376.

SAUVÉE, A., elected Member, 1874, 101.

SAVILL, A. S., Injector, *Paper* on the Automatic and Exhaust-Steam Injector, 1884, 167.—Remarks, 183, 186, 187.

SAW, DIRECT-ACTING CIRCULAR, *Paper* on a Direct-Acting Circular Saw for cutting steel hot, by F. W. Webb, 1875, 126.—Original saw used at Crewe, 126.—Difficulties of "stalling" removed by direct application of Brotherhood three-cylinder engine, 126.—Special loose coupling to saw shaft, 127.—Results in cutting steel ingots, 128.—Advantages of large saw in cutting out steel forgings, 128.

*Discussion.*—Webb, F. W., Improvements in manufacture of crank axles, 129.—Brotherhood, P., Three-cylinder engine, freedom from repairs, 130; packing for engine piston, 130; saw and engine mounted on travelling frame for cutting steel rails, 130.—Webb, F. W., Duration of Ramsbottom packing rings in locomotives, 130.—Williams, R. P., Application of saw to improve construction of railway crossings, 131.—Tweddell, R. H., Steel rails cut by a plain disc without teeth, 132; packing not required for pistons with the high speed of engine, 132.—Olrick, L., Amount of power saved by driving saw direct, 132.—Webb, F. W., Direct-acting mode of driving safer than driving through gearing, 132.

SAWYER, F. H. R., elected Member, 1882, 146.

SAXBY, J., elected Member, 1880, 9.

SAXON, G., elected Member, 1875, 315.—Decease, 1880, 10.—Mémorial, 8.

SCHAFFHAUSEN, Water-Power Machinery, 1874, 60, 72.

SCHNEIDER, H. W., Mines, Furness Iron, 1880, 372, 377.

SCHOFIELD, C. J., elected Associate, 1875, 315.

SCHÖNHEYDER, W., elected Member, 1883, 33.

Cold Air, Machines for producing, 1881, 125, 130.

Engine Recorder, 1884, 160.

Injector, Automatic, 1884, 182.

Locomotive, Brown's Tramway, 1880, 63.

Locomotives, Compound, 1879, 358, 361.

Power Transmission, 1881, 94.

Riveted Joints, 1881, 268, 279.

Steel, Tempered, Molecular Rigidity of, 1883, 91.

Tramways, Permanent Way, 1880, 220.

Water Meters, 1882, 88.

SCHRAM, R., elected Member, 1880, 310.

SCLESSIN IRON WORKS, visited at Summer meeting, Belgium, 1883, 513.—Description of Works, 535.

SCOTT, C. H., elected Graduate, 1882, 16.

SCOTT, D., elected Member, 1876, 57.

SCOTT, E., elected Graduate, 1881, 409.

SCOTT, F. W., elected Member, 1875, 36.

SCOTT, G. I., elected Member, 1881, 624.

SCOTT, I. M., elected Member, 1877, 26.

SCOTT, JAMES, elected Member. 1881, 409.

SCOTT, JOHN, elected Member, 1884, 199.

SCOTT-MONCRIEFF, W. D., elected Member, 1884, 2.

Compressed - Air Engines for Tramways, *Paper* on Compressed - Air Engines for Tramways, 1881, 649.—Remarks, 664, 676.

SCREW-BRAKE for railway trains, 1878, 68, 89, 90. *See* Brakes.

SCREW-BRAKE, Automatic, 1882, 500. *See* Brake.

SCREW PROPELLER, *Paper* on the loss of power in the Screw Propeller, and the means of improving its efficiency, by Hon. R. C. Parsons, 1879, 588.—Principles which affect action of propeller, 588.—Causes of rotation of water in wake of propeller, 589.—Rigg's propeller, with guide-blades abaft, 589.—Preliminary trials with model of improved propeller, 590.—Construction of full-size propeller &c., 590.—Loss due to skin friction on propeller-blades of *Lord Clyde*, 592.—Saving by new arrangement, 594.—Reduction of thrust upon thrust-block, due to application of guide-blades, 594.—Experiments on steamer *Louise*, 595.—Relative efficiencies of ordinary and of guide-blade propeller, 596.—Ditto with semi-cylindrical casing, 596.—Mode of designing angles of guide-blades and propeller-blades, 597.—Advantages and essential features of new arrangement, 597.—Mode of construction, 598.—Requirements for future improvements, 598.

*Discussion*.—Parsons, Hon. R. C., Present state of question, 599; forward thrust from guide-blades is in excess of drag due to friction, 600; increased efficiency due to reduction in speed of revolution, 601; distance between propeller-blades and guide-blades, 602.—Anderson, W., Relation of screw-propeller to turbine, 602; difficulty in experiments on steamer *Louise*, 603; comparative friction of propeller-blades and of water in pipes, 603.—Reynolds, O., Obliquity of guide-blade to propeller-blade seems very great, 604.—Parsons, Hon. R. C., Description of mode in which these angles were fixed, 604.—Reynolds, O., Old screw on steamer *Louise* badly designed, 605; forward motion of casing in model might be due to tapering shape, 606; loss of efficiency with larger propellers might be due to stream-line motion, 606.—Anderson, W., Reason for design of old propeller for *Louise*, 606.—Cowper, E. A., Value of increasing pitch for propeller-blades, 607; experiment should be made with same horse-power for new as for old screw, 607.—Walton, J., Was new screw tried without a casing, 607.—Parsons, Hon. R. C., New propeller always fitted with casing, 607; prevention of air from being drawn down into water, 608;



## SCREW PROPELLER (continued).

propellers with constant pitch now in favour, 608: forward motion of casing the same when cylindrical, 608.—Robinson, J., Three arrangements involved in new propeller should be tried separately, 609.

SCREW PROPELLER, Miers' cofferdam for removing, 1878, 179.

SCREW PROPELLERS. Griffith's, 1879, 608. Hirsch's, 608. Imray's, 608. Parsons', 588. Rigg's, 589.

SCREW WORKS, Nettlefolds', 1876, 327.

SCRIVEN'S RADIAL MULTIPLE DRILL, 1878, 577.

SEABROOKE, A. W., elected Member, 1882, 255.

SEATON, A. E., elected Member, 1882, 476.

SECRETARY, Nomination of, 1877, 302.

Vote to late Secretary, Mr. William P. Marshall, 1878, 20, 27, 108.

*Discussion.* — Robinson, J., Resolution to vote £3000, 1878, 108. — Williams, R. P., Was offer made of increased salary on removal to London, 109.—Robinson, J., Increase was offered to a small extent, 109.—Bramwell, F. J., Mr. Marshall's reasons for resigning, 110; salary formerly insufficient, 110.—Williams, R. P., Quite willing to support the motion, 111.—Walker, C. C., Members should have materials for forming opinion, 111.—Robinson, J., Particulars of salary, 112.—Paget, A., Average salary for thirty years, 112.—Bramwell, F. J., Salary rose rapidly at last, 112.—Walker, C. C., Sum proposed was not too great under circumstances, 112.—Head, Jeremiah, Subject had been most seriously looked into by Council, 113; Institution should err on liberal side, if at all, 113.—Cowper, E. A., Valuable services of Mr. Marshall, 114.

Special Meeting for appointment of Secretary, 1884, 77.—Bell, I. L., Applications received, and interviews with selected candidates, 77.—Carbutt, E. H., Motion to appoint Mr. Bache, 77.—Markham, C., Seconded motion, 77.—Davis, A., Amendment that Council be asked to state their views, 77.—Price, J., Seconded amendment, 77.—Amendment carried, 77.—Bell, I. L., Three names recommended by Council, 78.—Davis, A., Motion to appoint Mr. Holmes, 78.—Rich, W. E., Seconded motion, 78.—Motion negatived, 78.—Robinson, J., Motion to appoint Mr. Armstrong, 78.—Cochrane, C., Seconded motion, 78.—Motion negatived, 78.—Carbutt, E. H., Motion to appoint Mr. Bache, 78.—Markham, C., Seconded motion, 78.—Motion carried, 78.—Paget, A., Moved vote of thanks to President, 78.—Bramwell, Sir F., Seconded motion, 78.—Motion carried, 78.

SEED-SOWING MACHINERY, 1882, 231. *See* Sowing of Seed.

SEDDON, J. F., decease, 1884, 3.—Memoir, 68.

Accidents, Mine, Mechanical Appliances for, 1877, 342.

SELBY, M., decease, 1881, 11.—Memoir, 6.

SELFE, N., elected Member, 1882, 255.

SELLERS, C., elected Member, 1884, 80.

SELLERS' INJECTOR, 1884, 185.

SELWYN, ADM. J. H., Patent Laws, 1876, 186.

SENNETT, R., elected Member, 1881, 164.

SEPARATOR, CENTRIFUGAL, 1882, 519. *See* Centrifugal Separator.

SERAING, Works of the Society Cockerill, 1883, 511, 519. *See* Cockerill.

SEVERN TUNNEL WORKS, 1877, 297.—Visited at Summer meeting, Cardiff, 1884, 359, 395-397.

SEWAGE WORKS, Birmingham Corporation, 1876, 343.

SEWERS, Paris, visit to, 1878, 548.

SHACKLEFORD, A. L., elected Member, 1883, 179.

SHACKLEFORD, W. C., elected Member, 1884, 2.

SHAFTING, *Paper* on the Strength of Shafting when exposed both to Torsion and to End Thrust; by A. G. Greenhill, 1883, 182.—Formula of writer and of Euler, 182.—Application to screw-propeller shafting, 183.—Illustration from ss. *Dorset*, 185.—Note by Mr. W. J. Clark on percentage of power utilised in propulsion, 185.—Strength of hollow shafts, 187.—Hollow shaft of *City of Rome*, 188.—*Appendix*, theoretical investigation of the stability of shafting, 190-209.

*Discussion*.—Greenhill, A. G., Formula requires no factor of safety, 210; loss of power in marine propulsion, 210; hollow shafts, 210.—Rennie, G. B., Intermediate bearings of screw shaft are to carry weight of shaft, 210; no end-thrust on shaft, 211.—Cowper, E. A., Asked for examples of application of formula to broken propeller-shafts, 211.—Unwin, W. C., Stress due to twisting and thrust combined, 211; intermediate bearings can be dispensed with, 212; objection to numerous bearings, 212.—Reynolds, E., Example of breakage of propeller-shaft, 213; breakages of hollow crank-shafts, 214; need for centre core of material not under strain, 215; examination of cracked crank-shaft, 215; thrust on propeller-shaft not reduced in same proportion as loss of propelling power, 215; comparative tests of solid and hollow shafts, 215-220.—Kennedy, A. B. W., Difference immaterial between author's formula and Euler's, 220; author's formula does not include strength of material used, 221; question of hollow and solid shafts depends on physical as well as mathematical considerations, 222; action between strained and unstrained parts, 222.—Paget, A., Experiments of Mr. Reynolds on transverse strength only, not on torsion or end-thrust, 222.—Reynolds, E., Transverse strain has to be borne by screw-shaft, 223.—Shield, H., Hollow crank-shafts have in some cases worked well, 223.—Unwin, W. C., Limits of application for Euler's formula in iron and steel shafts, 224.—Kennedy, A. B. W., Shaft should not be treated simply as a long column, 224.—Greenhill, A. G., Reasons for doing away with intermediate bearings, 224;

## SHAFTING (continued).

object attempted in use of hollow shafts, 225.—Westmacott, P. G. B., Practice should be refined by theory, and theory strengthened by practice, 225.

SHAFTING, FRICTION OF, 1874, 190.

SHAFTS, LARGE, machine for sinking, 1874, 85.

SHANKS, A., Puddling, Mechanical, 1876, 285.

SHANKS, W., elected Member, 1884, 80.

SHANKS, W. W., elected Member, 1881, 9.

SHAPTON, W., elected Member, 1881, 409.

SHARP, H., Steel, Fluid-Compressed, and Guns, 1875, 298.

SHARP, T. B., elected Member, 1875, 36.

Injector, Automatic, 1884, 172.

Steel Compression by Steam, 1880, 412.

Zinc Manufacture in Belgium, 1883, 364.

SHARROCK, S. L., elected Member, 1882, 146.

SHAW, H. S. H., elected Member, 1879, 38.

Expansion Gear, Automatic, 1882, 432.

Printing Machinery, 1881, 524.

SHAW, J., elected Member, 1881, 624.

SHAW, J. L., Mines. *Paper* on the Hæmatite Iron Mines of the Furness district, 1880, 363.—Remarks, 376.

SHAW, W., JUN., elected Member, 1881, 409.

SHEARING, HYDRAULIC, 1874, 171.

SHED, LOCOMOTIVE RUNNING, 1884, 243. *See* Locomotive Running Shed.

SHEPHERD, J., Wood-Working Machinery, 1875, 261.

SHEPPARD, H. G., elected Graduate, 1875, 190.

SHIELD, H., elected Member, 1876, 347.

Presses, Hydraulic Packing, 1877, 355.

Pressure-Intensifying Apparatus, 1878, 55, 62.

Shafting, Strength of, 1883, 223.

SHIP, Steam-ship "City of Rome," 1880, 336. *See* Steam-ship.

SHIPBUILDING YARDS, visited at Glasgow meeting; Napier and Sons, 1879, 571; Elder and Co., 572; Denny Bros., 576. Visited at Barrow meeting, 1880, 478-480.

SHIPS, *Paper* on Iron and Steel as constructive materials for Ships, by J. Price, 1881, 553.—Proper mode of comparing iron and steel ships, 553.—Water-ballast trim, 554.—Relative price of iron and steel, 554.—Modes of regarding the increased dead-weight capacity in steel ship, 555.—Appendix, comparison between quantities and cost for a given vessel in iron and steel, 556.

*Discussion*.—Denny, W., Mode of calculating reduction in weight by substitution of steel for iron, 558; correction of figures in paper, 559;

## SHIPS (continued).

labour not reduced by use of steel, 559; allowance to be made for scrap, 560; structural cellular form for water-ballast tanks, 560.—Martell, B., Commercial advantage in favour of steel ship, 561; water ballast, 561; measurement capacity no greater in steel ship than in iron, 562.—Rogerson, J., Particulars of steel steamer trading to Bilbao, 562; advantages of steel over iron, 563; experiments showing smaller corrosion of steel plates, 563; composition of experimental steel and iron plates, 564.—John, W., Increased dead-weight capacity in steel ship, 564; water-ballast need not be increased in steel ship, 565; advantages or disadvantages must be independent of mode of viewing the question, 565; superior quality and reliability of steel, 565; behaviour of steel vessel on rocks, 566.—Withy, E., Behaviour of steel vessel on rocks, 566; objections to increasing carrying capacity by increasing size of hull, 566; steel screw steamer *Cyanus*, 567; importance of even small additional capacity, 567; cost of steel and iron in *Cyanus*, 569; change from iron to steel analogous to change in type of engines, 569; lighter draught of steel vessel, 570; no trouble in use of steel, 570; estimate of comparative net earnings of iron and steel vessels, 570.—Adamson, D., Corrosion of thick plates less important than of thin plates, 571; results of experiments on corrosion of steel and iron plates, 572; cold-water test unsuitable for shipbuilding steel, 572; relative longitudinal and transverse tensile strength of iron and steel plates, bars, and angles, 573.—Price, J., Cost of increased dead-weight capacity in steel cargo-carrier, 575; prices of steel and iron, 575; question of extras in plates, 576; mode of reducing net saving due to steel, 576; vital point is net cost of carrying capacity, 578; steel in itself preferable to iron, 578.—Denny, W., Extras for iron plates not reckoned, 579; mode of estimating reduction of weight due to steel, 579.

SHIPS, Hydraulic Machinery for, 1874, 33.—Hydraulic Propulsion of, 1878, 462.  
—Raising of wreck, 1878, 116.

SHOOLBRED, J. N., Electric Lighting, 1878, 540.—1880, 274.

Power Transmission, 1881, 87.

Rock-Drill, Diamond, 1875, 111.

Water Meters, 1882, 83.

SHOT AND SHELL against Armour Plates, 1879, 52. *See* Armour.

SHUTTLEWORTH, J., decease, 1884, 3.—Mémorial, 69.

SIEMENS, A., Power Transmission, 1881, 91.

SIEMENS, SIR C. W., decease, 1884, 3, 19.—Address of condolence to Lady Siemens, 8.—Mémorial, 69.

Armour, Construction of, 1879, 71.

Blast-Furnace Capacity, 1876, 33.

## SIEMENS, SIR C. W. (continued).

Cement, Portland, 1875, 59.

Chuck, Electro-Magnetic, 1875, 41, 44.

Compressed-Air Machinery, 1874, 217.

Condenser, McCarter, 1876, 311.

High-Pressure Vessels, *Paper* on the construction of Vessels to resist

High internal Pressure, 1878, 271.—Remarks, 275, 286, 287, 288, 289.

Hydraulic Machinery, Marine, 1874, 51, 52, 53, 54.

Iron, Homogeneous, 1877, 78, 81.

Patent Laws, 1875, 179.

Power Transmission by Ropes, 1874, 65, 75.

Puddling, Mechanical, 1876, 285.

Pump, Helical, 1874, 289, 290.

Rock-Drill, Diamond, 1875, 112, 122.

Rules, 1874, 30.—1875, 37.—1876, 30.—1877, 40.

Steel, Fluid-Compressed, and Guns, 1875, 285, 301.

Steel Boiler Experiments, 1878, 233-236, 265.

Steel Compression by Steam, 1880, 403.

Valve-Gear, Joy's, 1880, 444.

SIEMENS DYNAMO-ELECTRIC MACHINE, 1878, 530, 542.—1879, 249, 252.—1880, 266, 267, 268, 284. *See* Electric Lighting.

SIGNALS and POINTS, Application of Electro-Magnets to the working of Railway Signals and Points, 1884, 444. *See* Railway Electric Signals.

SILVER ORE AMALGAMATION, *Paper* on the Francke "Tina" or Vat Process for the Amalgamation of Silver Ores, by E. P. Rathbone, 1884, 257.—Processes previously in use, 257.—Ore dressing, 258.—Classification of ores, 258.—Stamping, 259.—Dust, 260.—Roasting, 260.—Amalgamating, 261; "tinas" or amalgamating vats, 262.—Rationale of process, 263.—Subliming, 264.

*Discussion.*—Frecheville, R. J., Composition of ore and gangue, 265; assays of tailings, 265; coffers might be made of wood, 265; limit of roasting, 266; removal of base metal chlorides by previous leaching, 266; comparison of tina with ordinary pan, 267; tina may be a good amalgamator, but is a poor grinder, 267; analyses desirable of ore, bullion, and tailings, 267.—Crampton, T. R., Fine crushing of minerals, 267; revolving disintegrator, 268; fine dust coal for foundry moulding, 268.—Nursey, P. F., Crushing of ore in gold-mining, 269.—Rathbone, E. P., Composition of ore and gangue, 270; advantage of coffers and dust-chambers, 270; limit of roasting, 270; leaching, 270; copper lining of tina facilitates amalgamation, 271; tina intended more for mixing than for grinding, 271; percentage of silver from ore, and in tailings, 271; extremely fine pulverisation undesirable, 271.



- SIMONDS, W. T., elected Member, 1877, 165.  
 SIMON, H., Gas Engine, Atmospheric, 1875, 211.  
 SIMPSON, A. T., elected Member, 1876, 57.  
 SIMPSON, C. L., elected Graduate, 1883, 34.  
 SIMPSON, J., elected Member, 1878, 107.  
 SIMPSON, J. H., elected Member, 1882, 255.  
 SIMS' COMPOUND ENGINE, 1874, 265.  
 SINGLE-LEVER TESTING MACHINE, 1882, 384. *See* Testing Machine.  
 SISSON, W., elected Member, 1881, 10.  
 SKERRETT, C. P., Dredger, Bazin, 1882, 106.  
 SLATER, A., South-Wales Mineral Wagons, *Paper* on the Mineral Wagons of South Wales, 1884, 415.—Remarks, 437, 442, 443.  
 SLIDE-VALVE, CIRCULAR, 1877, 197. *See* Valve, Circular Slide.  
 SLIDING-ROLL MILL for Plates, 1880, 87. *See* Plate Rolling Machinery.  
 SLIPWAYS, *Paper* on Slipways, by W. Boyd, 1881, 581.—Armstrong's system, 581.—Hayward Tyler and Co.'s system, 582.—Day Summers and Co.'s system, 583.—Thompson's system, 584.—Wallsend system, 585.—Machinery, 586.—Mode of working, 587.—Speed of working, 588.—Comparison with dry docks, 589.—Relieving, 590.—Lengthening of vessels, 592.—*Appendix*, calculation of power required to haul vessels up slipway, 593.—Table showing power actually required, 594.  
 SLUICES FOR CULVERTS, 1874, 155.  
 SMALL ARMS FACTORY, Birmingham, 1876, 329.  
 SMETHURST, W., elected Member, 1876, 28.  
 SMITH, A. D., elected Member, 1879, 38.  
 SMITH, C., decease, 1883, 36.—*Memoir*, 25.  
 SMITH, C. H., elected Member, 1879, 398.  
 SMITH, H., elected Member, 1881, 624.  
 SMITH, J., elected Member, 1876, 28.  
 SMITH, J. B., elected Member, 1883, 179.  
 SMITH, J. P., elected Member, 1877, 299.—Decease, 1879, 22.—*Memoir*, 16.  
 SMITH, M. H., Fire-Feeder, Frisbie Mechanical, 1876, 322.  
     Mining Machinery, 1882, 379.  
 SMITH, R. H., elected Member, 1881, 409.  
     Friction Experiments, 1883, 655.  
 SMITH, WASTENEYS, elected Member, 1881, 409.  
 SMITH, WILLIAM (London), decease, 1879, 22.—*Memoir*, 16.  
     Chuck, Electro-Magnetic, 1875, 41, 43.  
     Patent Laws, 1875, 169, 181, 184, 185.—1876, 182, 188.  
     Power Transmission by Ropes, 1874, 72.  
     Rope Gearing, 1876, 393.  
 SMITH, WILLIAM (Glasgow), decease, 1882, 17.—*Memoir*, 12.

- SMITH, W. FORD, Cutting of Metals, *Paper* on some modern systems of Cutting Metals, 1883, 226.—Remarks, 252, 266.  
 Gas Engine, Atmospheric, 1875, 209.  
 Steel, Chernoff's papers, 1880, 237.
- SMITH, W. PARKER, elected Member, 1882, 255.  
 Brake, *Paper* on the Automatic Screw-Brake, 1882, 500.—Remarks, 508, 509, 515.
- SMITH-HARDY VACUUM BRAKE for railway trains, 1878, 71, 87, 484, 554, 592, 607, 622, 624, 630.
- SMYTH, J. J., elected Member, 1882, 255.  
 Hammers, Power Hammers with Movable Fulcrum, 1882, 211.  
 Sowing of Seed, *Paper* on machinery for the Sowing of Seed, 1882, 231.—Remarks, 244, 248.
- SMYTH, W. S., elected Member, 1884, 199.
- SNELUS, G. J., elected Member, 1883, 593.  
 Steel Compression by Steam, 1880, 409.
- SOKELL, J. H., elected Associate, 1882, 255.—Decease, 1884, 3.—Memoir, 71.
- SOLENOID MAGNET, 1884, 445, 462, 468. *See* Railway Electric Signals.
- SOLLORY, G. H., elected Graduate, 1884, 409.
- SOLLY, A. J., elected Graduate, 1879, 156.
- SOPWITH, T., JUN., elected Member, 1878, 31.
- SÖRENSEN, B., decease, 1878, 22.—Memoir, 14.
- SOULSBY, J. C., elected Member, 409.
- SOUTH-WALES MINERAL WAGONS, *Paper* on the Mineral Wagons of South Wales, by A. Slater, 1884, 415.—Private owners' wagons, 415.—Various types of wagons, 416.—Proportion between paying load and dead weight, 416.—Increase in cubic capacity and in dead weight, 417.—Principal dimensions of coal wagons of different tonnages, 418.—Body, 417.—Doors, 419.—Floor, 419.—Framing, 419.—Draw-gear, 420.—Buffers, 420.—Axle-guards, 422.—Brakes, 422.—Bearing brasses, 422.—Bearing springs, 423.—Wheels and axles, 423.—Coke wagons, 423.—Iron-ore and rail wagons, 423.—Iron-framed wagons, 424.—Size of wagons, 425.
- Discussion.*—Riches, T. H., Comparison desirable with wagons of other districts, 426.—Price-Williams, R., Life-value of rolling stock, 426; legitimate increase in tare, 427; proportion between paying load and dead weight, 427; effect of buffers on life-value, 427; iron-framed wagons, 429; limit of weight, 429.—Johnson, S. W., Objection to iron-framed wagons, 429.—Clayton, T. G., Former iron-framed wagons, 430; life-time of railway wagons, 430; adoption of spring buffers, 430; relative cost of long laminated buffer-springs and outside buffers, 431; capacity of wagons, 431.—Ashbury, T., Effects of decrease in paying load, and of increase in capacity and tare, 431.—Gordon, R., Increased capacity of wagons in

## SOUTH-WALES MINERAL WAGONS (continued).

United States, 432.—Hughes, G. D., Propriety of increasing the carrying capacity, 433.—Tweddell, R. H., Action of india-rubber buffer spring, 433; simplification of wagon construction, 434; damage from collision, 434; relative cost of iron or steel underframe and one of timber, 434.—Paget, A., Construction of india-rubber buffer and draw-bar spring, 434.—Head, J., Increasing use of iron and steel for other purposes, 435; iron hopper-wagons on North Eastern Railway, 435; mild soft steel suitable for wagons, 435; use of springs, 436; ownership of railway wagons, 436; research experiments on friction, 436.—Slater, A., Explanation of average of tare, 437; life-value of wagons with light and heavy tares, 437; probable adoption of iron underframes, 437; importance of hydraulic riveting, 438; increase in capacity and tare, 439; collisions, 439; life-time of wagons, 440; spring buffers, 440; india-rubber buffer and draw-bar spring, 440; benefit from increased carrying capacity, 441; difficulties of increasing capacity of colliery wagons, 441; wagons of large carrying capacity, 442; ownership of wagons, 442.—Cochrane, C., Appearance of india-rubber buffer spring, 442.—Slater, A., Description of india-rubber buffer spring, 442.—Paget, A., Action of india-rubber spring, 443.—Slater, A., Advantages of india-rubber spring, 443.—Cochrane, C., Train-miles of wagons, 443.

SOWING OF SEED, *Paper on machinery for the Sowing of Seed*, by J. J. Smyth, 1882, 231.—Delivery of the seed to the sower, 231.—Aperture delivery, 232.—Force-feed delivery, 232.—Cup delivery, 234.—Regulation of the quantity of seed to be sown, 236.—Bringing of the seed to the soil, 239.—Broadcast sowing machine, 239.—Corn and seed drills, 239.—Drill frame, 240.—Coulter levers, 241.—Seed conductors, 242.—Steering apparatus, 243.

*Discussion.*—Smyth, J. J., Model of early Suffolk drill, 244; drills must be adapted to all countries and kinds of grain, 244; superiority of side-cup system over indented-disc, 245; best shapes for coulters, 246; defects of previous conductors, 246.—Anderson, W., Testing of seed distribution at Royal Agricultural Society's show, 247; weakness of coulter-levers, 247; seed-box not protected from wet, 247; uniform delivery obtained from pitch-chain distributor, 248.—Smyth, J. J., Side-cup drill requires cups to be set properly, 248; proper construction of coulter-levers, 249; protection of seed-box from wet, 249; objection to distribution by pitch-chain, 249.—Westmacott, P. G. B., Thanks due for diagrams as well as paper, 250.

SOYRES, F. J. DE, elected Member, 1877, 299.

SPECIAL MEETING for appointment of Secretary, 1884, 77. *See* Secretary.

SPECK, T. S., elected Member, 1876, 57.—Decease, 1884, 3.—Memoir, 71.

SPENCER, A. G., elected Member, 1878, 108.

- SPENCER, E., Cotton-Spinning Machinery, *Paper* on recent improvements in the Machinery for Preparing and Spinning Cotton, 1880, 492.—Remarks, 528.
- SPENCER, G., elected Member, 1878, 108.
- SPENCER, J., elected Member, 1877, 299.
- SPICE, R. P., elected Member, 1876, 57.
- SPIELMANN, M. H., elected Graduate, 1877, 300.
- SPINNING MACHINERY for Cotton, 1880, 492. *See* Cotton Spinning Machinery.
- SPINNING MACHINERY for Jute, 1880, 389. *See* Jute Machinery.
- SPITTLE, T., decease, 1882, 17.—Memoir, 12.
- SPON, E., Portable Railways, 1884, 148.  
Water Supply from Chalk, 1876, 172.
- SPOONER, H. J., elected Graduate, 1883, 180.
- SPRAY TUYERE, 1876, 350. *See* Tuyere, Open Spray.
- SPRIGGS, C., elected Member, 1876, 28.—Decease, 1878, 22.—Memoir, 15.
- SPRING MEETING, Business, 1874, 55.—1875, 65.—1876, 57.—1877, 71.—1878, 107.—1879, 155.—1880, 185.—1881, 163.—1882, 145.—1883, 179.—1884, 79.
- SPRINGS, HELICAL, best proportions for construction, 1877, 192.
- STAFFORD, G., elected Member, 1880, 310.
- STAMPING OF METALS, principles of, 1878, 317.
- STANGER, G. H., elected Member, 1877, 299.
- STANGER, W. H., elected Member, 1875, 65.
- STANTON, F. B., elected Member, 1884, 409.
- STEAD, J. E., Blast-Furnace Working, 1883, 138, 151.
- STEAM ACCUMULATOR for Hydraulic Machines, 1874, 34, 50.
- STEAM BAKERY, Cardiff, 1884, 367.
- STEAM COMPRESSION of Steel, 1880, 396. *See* Steel Compression by Steam.
- STEAM, CONDENSATION, in long pipes, 1874, 270, 276, 279.
- STEAM DOME, 1876, 68, 88.
- STEAM DYEING AND LAUNDRY WORKS, Cardiff, 1884, 366.
- STEAM-ENGINE GOVERNORS regulating Expansion, 1882, 408. *See* Expansion Gear.
- STEAM for transmitting power, 1881, 96. *See* Power Transmission.
- STEAM-SHIP, *Paper* on the Steam-ship "City of Rome," by J. Humphrys, 1880, 336.—Development of British mercantile marine, 336.—Dimensions of "City of Rome," 337.—General features, 337.—Arrangement of boiler rooms, 338.—Stern post, framing, and shell plating, 339.—Engines, 340.—Crank shaft, 341.—Particulars of engines, 341.—Boilers, 342.—Internal arrangements, 342.—Weight, displacement, and capacity, 345.  
*Discussion.*—Boyd, W., Objectionable use of gearing for working valves, 345; why were boilers made of iron, not of steel, 345.—Ormiston, T., Advantages of having saloon amidships, 346; importance of adequate

## STEAM-SHIP (continued).

strength in long ships, 346.—Reynolds, E., Superiority of solid to hollow shafts, 346.—Adams, T., Greater torsional resistance of hollow shaft, 348; superiority of steel plates for boilers, 348.—Hall, W. S., Natural hollow structure is not exposed to torsion, 348.—Paget, A., Strength of hollow bamboo, 348.—Reynolds, E., Torsional strength distinct from long endurance of strains, 349.—Marshall, F. C., Advantage of twin-screw arrangement, 349; novelty of three pairs of tandem engines, 349; gearing for working the valves objectionable, 349; hollow crank-shaft how built up, 350; reciprocating pump why preferred to centrifugal, 350; boiler joints how made, 350.—Humphrys, J., Mode of building up crank-shaft, 350.—Robinson, J., Advantages of ingot iron for boilers, 351.—Adamson, D., Superiority of hollow to solid shafts, 352; varieties of quality in steel, 353; advantages of three pairs of tandem engines, 353; ingot-metal preferable to iron for boilers, 353.—Greig, D., Steel should now supersede iron for boilers and ships, 354.—Crampton, T. R., Steel plates to be used with caution, 354.—Robinson, J., Thick plates of ingot metal for locomotive frames, 355.—Welch, E. J. C., Results of testing thick steel plates, 355.—Marshall, F. C., Use of very thick iron plates for marine boilers, and advantage of steel plates, 356.—Reynolds, E., Building up of steel cranks, 357.—Cowper, C. E., Suggestion of simple nomenclature for iron and steel, 357.—Cowper, E. A., Advantages of steel plates for boilers and ships, 358; use of iron decks, 358.—Humphrys, J., Ample security in use of gearing for slide-valves, 358; boiler plates of iron on account of size, 358; position of saloon, how fixed, 359; large vessels can be made amply strong, 360; advantages of hollow shaft, 360; ditto of tandem engines, 360; ditto of reciprocating pumps, 361; ships will be built of steel when price lower, 361.

STEAVENSON, A. L., Printing Machinery, 1881, 523.

Ventilators for Mines, Mechanical, 1876, 329.

STEEL, T. D., elected Member, 1874, 55.

Tynnewydd Colliery Inundation, 1877, 230.

STEEL AND GUNS, *Paper* on Fluid-Compressed Steel and Guns, by Sir J. Whitworth, 1875, 268.—Correction of definition between wrought iron and steel, 268.—Standard proposed, designating combined tensile strength and ductility, 269.—Mould box and process for compressing fluid steel, 270.—Forging by hydraulic press, advantage over steam hammer, 271.—Guns should be made of steel, 272.—Results of testing the strength of compressed steel by explosion of gunpowder, 272.—Breech-loading guns, superior results to muzzle-loading, 273.—Great strength of compressed steel allows more powder to be used than muzzle-loader can consume, 274.—Guns made of fluid-compressed steel at less cost than by wrought-iron



## STEEL AND GUNS (continued).

process, 274.—Steel breech-loading guns of moderate size with large powder chambers, superior to muzzle-loaders of large size, 275.—Long projectiles give greater penetration than short ones, 275.—Flat-headed projectiles necessary for penetrating under water, 276.—Importance of having adequate bearing surface for rifled shot, 276.—Polygonal projectiles less expensive than studded, 277.—Length of projectile should be three diameters, 277.—Projectile with conoidal front and slightly tapered rear found best for long ranges in all cases, 278.—Table of experiments on cylinders with gunpowder explosions, 279.—Table of tensile strength and ductility of fluid-compressed steel, 280.

*Discussion.*—Whitworth, Sir J., Proof that flat-headed projectiles are necessary for penetration under water, 281; results of experiments for testing strength of metals by explosions of gunpowder, 281.—Ramsbottom, J., Compressed steel cast quite sound and free from cells, 283; definition of iron and steel should be determined by tensile strength and ductility, 283; hydraulic forging press better than steam hammer mechanically, only question whether better commercially, 284; welded iron, impossible to be sure of soundness, 285.—Siemens, C. W., Difficulty in accounting for gas being expelled by pressure upon a fluid, 286; fluid metal contains large quantity of gas occluded within itself, which if retained becomes source of weakness, 287; proposed definition of “iron” and “steel” limited to metal that has been fluid, 287.—Cowper, E. A., Combined effect of high temperature and pressure on the gas in fluid steel, 289; carbonic oxide formed by puddling action in the mould, 289.—Rennie, G. B., Compressed steel successfully applied to large propeller shafts, with great saving of weight, 289.—Whitworth, Sir J., Fluid steel column shortened 1–8th by the compression, 290; gas expelled by pressure from fluid steel is 9–10ths common air, 290; classification and characteristics of different qualities of compressed steel, 291; value of high tensile strength combined with great ductility, 291.—Carpmael, W., Effect of compressing fluid steel to expel gas held in solution, 291.—Davey, H., Increased strength of compressed steel probably due to different aggregation of the particles, 292.—Mather, W., Probable advantages of fluid compression applied to iron castings, 292.—Webb, F. W., Moulds for steel require special preparation for escape of gas, to prevent piping and bubbles, 293; large ingots can be cast quite sound, 293; phosphorus a great help in obtaining clean castings, where forging not required, 293; mild cast steel with as much as 33 per cent. of ductility made with great uniformity for boiler plates at Crewe Works, 294; steel for fire-boxes required to be tempered very low, 294.—Whitworth, Sir J., Steel ingots, cast in ordinary way, and having 30 per cent. of ductility, are never sound, 295; pressure of 6 to 8 tons per

## STEEL AND GUNS (continued).

square inch sufficient for getting rid of air-cells in steel, 295.—Webb, F. W., Steel ingot cast with a 4 ft. head, free from air-cells, 296.—Deacon, G. F., Expulsion of gases commences with congelation, 296.—Adamson, D., Soundness of compressed steel accounted for mechanically, and not requiring chemical explanation, 297; impossible to get solid ingot cast in ordinary mould, from contraction of centre after surface becomes solidified, 297; large iron castings never so close in centre as at outside, 298; high tensile strength incompatible with high ductility in iron, 298.—Sharp, H., Bessemer steel ingots cast under head of metal have high tensile strength and ductility, 298.—Cochrane, C., Reduction in bulk of steel in compression due partly to expansion of mould, 299.—Reynolds, E., Process of fluid compression used extensively for copper, 299; ordinary steel ingots cast quite sound if “dead melted,” to prevent metal from rising in mould by evolution of gas, 299; arrested evolution of gas recommences on cooling from very high temperature, 299; sound ingots obtained by “dead melting,” allowing time for escape of gas, 300; tank furnaces for steel-making require very high temperature to reduce intensity of chemical action, 301.—Siemens, C. W., Dissociation at high temperature in steel-melting furnace, 301.—Preston, F., Importance of getting rid of the air for obtaining good castings, 302.—Webb, F. W., Castings in a vacuum, 303.—Whitworth, Sir J., Results of experiments for testing tensile strength and ductility of wrought and cast iron, 303; long annealing required with Krupp steel from containing more carbon, but no annealing required with fluid-compressed steel, 304.

STEEL AND IRON FOR BOILERS. *See* Iron and Steel for Boilers, 1879, 268.—Steel Boiler Experiments, 1878, 217.

STEEL AND IRON FOR SHIPS, 1881, 553. *See* Ships.

STEEL BOILER EXPERIMENTS, *Papers* on experiments relative to Steel Boilers, by W. Boyd, 1878, 217.—Design for steel boiler for a steam-ship built wholly of steel, 217.—Tests required for material by Lloyd's committee, 217.—Steel rivets and steel tubes used in construction of boiler, 218.—Tensile tests, 218.—Tests of longitudinal joints, 219.—Tests of punched and drilled holes, 222.—Tests of steel rivets, 223.—Buckling tests of stayed flat plates without nuts on stays, 224.—Ditto with nuts on stays, 225.—Tempering tests, 226.—Annealing tests, 227.—Conclusions, 227.—Tables of tests, 228–232.

*Discussion.*—Siemens, C. W., Cause of apparent failure of Landore steel, 233; use of iron rivets for mild steel plates is most objectionable, 234; effect of punching depends on method adopted, 234; American helical punch, 235; harder steel would be better for flat stay-plates, 235; impossibility of bursting a steel boiler, 236.—Bramwell, F. J., Importance

## STEEL BOILER EXPERIMENTS (continued).

of fitting nuts on stays, as shown by exploded boiler and by experiments, 236.—Tweddell, R. H., Punching should supersede drilling if possible, to save expense, 237; advantages of punching, 238; different views as to loss of strength from punching, 238; result of experiments with spiral punch, 239; iron rivets superior to steel for steel boilers, 240; use of steel boilers in French navy, 240; use of steel for different structures should be investigated under direction of the Council, 241.—Hill, L., Process for punching large holes without powerful punching machine, 241.—Paget, A., Clearance between die and punch is a very important point, 242; method of punching small pieces of complicated shapes out of thin cast-steel plate, 242.—Sterne, L., Experiments with spiral punch, 243.—Parsey, W., Punch made with end hollowed out at centre is better than with flat end, 244.—Wicksteed, J. H., Rule for clearance between punch and die, 244; method of gripping test-pieces, 245.—Head, Jeremiah, Suitability of mild steel for boiler-making, 245; use of steel boiler-plates is largely a question of price, 246; different views as to corrosion of steel and iron, 246; subject should be investigated by Institution, 246.—West, H. H., Element of time conjointly with that of strain is important, 247.—Adamson, D., Investigation by Institution is not desirable, 248; statement as to permanent set is not in accordance with his own experience, 249; different results with short and long specimens, 249; punching could never supersede drilling, 250; undesirability of having conical rivet-holes for steel boiler, 251; reduction in section of plates under compression is not desirable, 252; advantage of drilling instead of punching, 253; treacherous nature of plate iron, 253; danger arising from cinder in plate iron, forming an "iron concrete," 253.—Cowper, E. A., Steel for boilers and rivets should be mild, 255; description of "extensometer" for measuring elastic limit, 256; method of punching out large eyes in iron suspension-bridge links, 257.—Hawksley, T., Question of permanent set as affected by repetition of strain, 258; desirability of investigating effect of foreign substances upon pure materials, 259; steel is very much less corrosible than iron, 260.—Olrick, L., Differences of opinion as to punching are due to difference in material tested, 260; testing pressure should not be more than 50 per cent. above working pressure, 261; sharp edges of rivet-holes should be taken off, 262; difficulty of bending plates into conical shape, 262.—Platts, J. J., Steel plates would not stand for anthracite fuel, 263; drilled holes are far superior to punched, where metal has to contend with very great heat, 264.—Adamson, D., Steel fireboxes found not to be injured by anthracite, 264.—Platts, J. J., Short steel fireboxes in locomotives in Russia had all cracked, 265.—Siemens, C. W., Very mild steel has not been known very long, 265.—Platts, J. J.,

## STEEL BOILER EXPERIMENTS (continued).

Steel plates of Russian locomotive fireboxes were got four years ago, 265.  
 —Tweddell, R. H., Steel not yet adopted for furnaces in French navy, 265.  
 —Boyd, W., Mode of conducting tensile experiments and ascertaining permanent set, 266; mode of heating rivets, 267.—Robinson, J., How was over-heating or under-heating prevented, 267.—Boyd, W., Reverberatory furnace used for heating rivets, 267; ordinary rivet-hearth unsuitable for steel rivets, 267; additional strength from nutted stays, 268; good work can be produced with punching machine, 268; description of punching machine used for steel boiler, 268; life of steel fireboxes can be proved only by time, 269.—Robinson, J., Still considerable uncertainty on various points, 270.

STEEL, CHERNOFF'S PAPERS, *Paper* (1878) on the Structure of Cast-Steel Ingots, by D. Chernoff, translated by W. Anderson, 1880, 152.—Previous use of wrought and cast iron, 152.—Early attempts at steel founding, 153.—Structure of steel ingot cast in metallic mould, 153.—Cavity in upper end, 154.—Bubbles in outer surface, 155.—Form and growth of ditto, 156.—Setting of steel, from surface inwards, 160.—Formation of crystals in ditto, 160.—Cause of acicular formation in outer layers, 164.—Granulation in cooling, 165.—Malleable cast iron, 167.—Methods of overcoming these defects in steel castings, 167.—First method, ingots hammered or rolled into required shapes, 168.—Tests of specimens from forged ingot, 169.—Second method, compression of fluid steel during setting, 170.—Results attained, 172.—Third method, use of chemical reagents to arrest formation of gases, 172.—Ferro-manganese-silicon meltings produced at Terre-Noire, 174.—Soundness of castings produced, 175.—Arborescences inside bubbles in central parts of steel ingots, 176.—Mode of preventing porosities by rotation of ingots while cooling, 177.—Centrifugal casting, 178.—Neither forging nor pressure necessary to improve steel, 179.—Tables of experiments on steel at Terre-Noire and at Abouchoff, 182-3.

STEEL, CHERNOFF'S PAPERS, *Paper*, Remarks on Chernoff's papers on Steel, by W. Anderson, 1880, 225.—Abouchoff steel works, 225.—Chernoff's first paper on the manufacture of steel, 226.—Second paper on the study of the Bessemer process, 227.—Third paper on the structure of cast-steel ingots, 228.—Effect of occluded gases on hardening and tempering of steel, 228.—Rapidly of diffusion of hydrogen through red-hot steel, 229.—Specific gravity of steel apparently reduced, but really increased by hardening, 229.—Softening of hardened steel by slow re-heating, 230.—Explanation of characteristic colours in tempering, 230.—Hughes' induction-currents balance, 231.

*Discussion.*—Anderson, W., Hughes' experiments on occluded gases with steel wire, and Roberts' with palladium wire, 232.—Cowper, E. A.,

## STEEL, CHERNOFF'S PAPERS (continued).

Brass wire becomes rotten by long exposure, 232.—Hall, W. S., Colours in tempering analogous to mother-of-pearl, 233.—Cowper, E. A., Prismatic effect of close fine lines on steel and glass, 233.—Paget, A., Such colours entirely different from colours of tempering, 233.—Hughes, D. E., Soft steel is mechanical mixture of iron and carbon, not chemical compound, nor alloy, 233; demonstration by differences in electro-motive force, 234; demonstration by electro-negative force, 235.—Cowper, E. A., What difference in conducting power between hard and soft steel, 235.—Hughes, D. E., Conducting power of hard steel lower than of soft, 235.—James, J., Difficulty of hardening cast-steel collars and cutters, 236; welding of steel, 236; form of edge more important than hardness for cutting tools, 236.—Smith, W. F., Welding of steel by borax and sal ammoniac, 237.—Cowper, E. A., Ditto by borax alone, 237.—Hughes, D. E., Steel is softest immediately after softening, and gradually hardens, 237.—Paget, A., Conversely, steel when too hard gradually softens, 237; straightening of very thin steel plates immediately after hardening, 237.—Beaumont, W. W., Hardness of Mushet's unhardened tool-steel, 238.—Robinson, J., Ductility of cast as compared with forged steel, 238.—Head, Jeremiah, Hammering of steel ingots now superseded by rolling, 238.—Robinson, J., Rolling has similar effect to hammering, 239.—Cowper, E. A., Annealing in oak sawdust, and chilling in hot water, 239.—Ferne, J., American plan of annealing and re-steeling, 240.—James, J., Annealing and re-hardening of pinny steel, 240.—Anderson, W., Soft steel ought to be weaker than hard, if containing carbon as graphite, 241; effect of extreme cold upon pure steel, and upon steel containing phosphorus, 241; swelling of steel on hardening, 242; cracking of dies used for coining, 242.—Robinson, J., Elliptical cracks inside bars of unhardened steel, 243.—Anderson, W., Specific gravity really greater in hardened steel, 243; annealed steel castings as strong as steel forgings, 243; use of steam pressure in casting steel ingots, 244.

STEEL, CHERNOFF'S PAPERS, *Paper* (1868) on the Manufacture of Steel, and the mode of working it, by D. Chernoff, translated by W. Anderson, 1880, 286.—Best steel ever made is "boulat" of Tartars, 286.—Ribbons of dead tint in steel guns, 287.—Effects of steam hammer in forging ingots, influence of temperature in tempering, and of agitation in cooling of melted steel, 288.—Nitrogen in steel, 289.—Influence of different metals on quality of steel, 289.—Tungsten steel, 290.—Law regulating change of structure by heating, 290.—Power of steel to become granular, 293.—Advantage of fine-grained structure, 294.—Forging at temperatures above amorphous condition does not increase density of steel, 294.—Heavy forging necessary for closing bubbles and cracks, 295.—Strength of unforged and forged



## STEEL CHERNOFF'S PAPERS (continued).

steel, 296.—Heated ingot must be forged as quickly as possible, 296.—Crystallisation in steel cooling quietly from high temperature, 297.—Mode of correcting crystallisation, by re-heating and quickly forging, 298.—Example of spoiling large steel ingot, 299.—Cavity in forging, 300.—Welding, 301.—Forging at temperatures below amorphous condition increases density of steel, 302.—Other results of forging at low temperature, 303.—How to obtain fine-grained structure, 304.—Tempering and cooling, 305.—Illustration by fractured specimens, 305.—Fixing of amorphous condition by plunging heated steel into water, 306.—Fine grain can be restored to steel that has become crystalline, 307.—Tempering of steel gun linings at Woolwich arsenal, 307.

STEEL COMPRESSION BY STEAM, *Paper* on the Steel-Compressing arrangements at the Barrow Works, by A. Davis, 1880, 396.—Causes of unsoundness in steel castings, 396.—Compression of fluid steel by high-pressure steam, 396.—Arrangements at Edgar Thompson Works, 397.—Ditto at Barrow Works, 397.—Joint for lid and base of ingot mould, 398.—Supply of steam, 398.—Attempt to inject water through cover of mould, 398.—Results of casting under steam compression, 399.—Pressure of steam required, 399.—Advantage of elastic compressing medium, 400.

*Discussion.*—Richards, E. W., Increased soundness of steam-compressed ingots under increased pressure, 400; gases occluded in steel are hydrogen and nitrogen, 401; necessity of expelling gases to get sound steel, 402.—Cowper, E. A., Whether mechanical expulsion of gas, or chemical absorption, 402.—Richards, E. W., Mechanical expulsion of gas, 403.—Siemens, C. W., Very high pressure necessary for compression of mild steel, 403; gases probably remain occluded, not expelled, 404; recent failure of steel boiler through defect of material, 404; mild-steel boiler will not burst under any pressure, 405; reliability of mild steel, 405; cheapness too much studied in mild steel, 406; steel rivet-bars, 406.—Adams, T., Experiments on strength of mild steel plates, 407; strength of compressed steel due to condensation, 407.—Paget, A., Mode of testing steel plates, 408.—Adams, T., Description of mode of testing, 408.—Snelus, G. J., Mechanical method of getting rid of bubbles in steel, 409; nature of gas in cavities, 409; occlusion of gases by various metals, 410; lower affinity of steel for hydrogen than carbonic oxide, 410; metal under pressure probably occludes more gas, 411; chemical means of getting rid of bubbles, 411.—Hayes, J., Admission of steam at both ends of mould for compression, 411; hydraulic power preferable for higher pressures, 412.—Sharp, T. B., Casting of copper ingots sound by mechanical means, 412; superiority of chemical over mechanical treatment, 412; three sorts of bubbles in cast metal, 412; advantage of chemical treatment for

## STEEL COMPRESSION BY STEAM (continued).

complicated castings, 413.—Cowper, E. A., Mild-steel boiler made for testing by hydraulic pressure, 413.—Paget, A., Similar process previously devised in France, 414; compression by use of air, 414; comparative effect of gaseous pressure and of solid ram, 414.—Crompton, R. E. B., Possible advantage of steam, by forming ammonia, 414; expulsion of occluded gases in Edison's experiments, 415.—Tweddell, R. H., Specific gravity of ingots subjected to pressure, 415.—Richards, E. W., Gases obtained were from steel not compressed, 415.—Davis, A., Amount of pressure required, 415; prompt application of pressure to fluid metal, 415; independent invention in France and America, 416; use of compressed air, 416; joints for ingot moulds, 417.

STEEL, HARDENING & C. OF STEEL, *First Report of the Committee on the Hardening, Tempering, and Annealing of Steel* (W. Anderson reporter), 1881, 681.—Nature and composition of steel and cast iron, 681.—Quantity of carbon in steel and cast iron, and its state, 683.—Substances other than carbon entering into the composition of steel, 686.—Hardening of steel, 687.—The molecular changes that occur in hardening, tempering, and annealing, 689.—Directions in which further investigation appears to be needed, 693.—Appendix, list of works consulted, 694.

STEEL, HARDENING & C. OF STEEL, Results of preliminary experiments with thin discs of Steel, by F. A. Abel, C.B., F.R.S., 1881, 696.—Description of first series of steel discs, and mode of treatment, 696.—Percentages of carbon in hardened, tempered, and annealed steel discs, 698.—Hardening and annealing processes, 699.—Second series of steel discs, percentages of carbon, 700.—Percentages of uncombined carbon, 701.—Residues from treatment with chromic acid liquor, 701.—Presence of iron carbide in steel, 704.—Effect of annealing and hardening, 704.

STEEL, HARDENING & C. OF STEEL, Results of experiments with reference to Occluded Gases, by W. Chandler Roberts, F.R.S., 1881, 706.—Former experiments in this direction, 707.—Experiments on hardening of steel in vacuo, 708.—Absence of characteristic colours when tempering in vacuo, 710.—Réaumur's views, 710.

STEEL, HARDENING & C. OF STEEL, Remarks by W. Anderson on experiments of Prof. W. Chandler Roberts and Prof. Abel, 1882, 37.—Ditto, by E. A. Cowper, 38; ditto by A. B. W. Kennedy, 38.

STEEL, HARDENING & C. OF STEEL, *Discussion*.—W. Anderson, Matter still in progress, 1882, 146.—Dugard, W. H., Diagrams lent by Prof. Norris of experiments on steel and iron wire, 146.—Abel, F. A., Experiments on carbide of iron in steel, 147; relation between specific gravity of steel and percentage of carbon, 148; tempering of steel at low temperature, 148.—Paget, A., Annealing of steel between wrought-iron plates, 149.

STEEL, HARDENING &c. OF STEEL, *Report on Further experiments bearing upon the question of the Condition in which Carbon exists in Steel*, by F. A. Abel, 1883, 56.—Previous stage of enquiry, 56.—Modes of annealing experimental steel discs, 57.—Decarbonising by contact with wrought iron, 57.—Composition of iron carbide from annealed steel, 58.—Preparation of chromic acid solutions, 60.—Results of treatment of steel in chromic solutions, 64.—Carbon in cold-rolled steel exists as iron carbide, 67.

*Discussion.*—Hughes, D. E., Objection to use of platinum sieves, 68.—Bramwell, Sir F. J., Analogy between hardened steel and chilled cast-iron, 68.—Abel, F. A., Relation of Report to hardening of steel, 69; use of platinum sieves, 69; analogy between hardened steel and chilled cast-iron, 70; Clemendot's experiments on hardening red-hot steel by pressure, 70.—Westmacott, P. G. B., Valuable record of experiments, 71.—Abel, F. A., Assistance of Mr. Deering, 71.

STEEL PLANT, *Paper on Bessemer Steel Plant, with special reference to the Erimus Works*, by C. J. Copeland, 1881, 627.—Cupolas and metal ladles, 627.—Spiegel cupolas, converters, and tipping gear, 628.—Casting crane, ingot cranes, draining of crane pits, accumulator, 629.—Pumping engines, blowing engines, lime infuser, 630.—Changing of converters, relining of ditto, utilising waste heat from ditto, 631.—Turner's marine boiler, 632.

*Discussion.*—Copeland, C. J., Disuse of spiegel crane, 632.—Walker, B., Comparison of ingot crane with other constructions, 632; advantage of compound blowing engines, 634; new blowing engines for Hayange, 635; best form of steam-jacket, 636; changing or relining of converter, 636; mode of lining for bottom of converter, 637; marine boiler a mistake for steel works, 637.—Adamson, D., Piston-valves for blowing engines, 637; economy of water in hydraulic cranes, 638; comparison between marine and Lancashire boilers, 638.—Cochrane, C., Advantages of Root's boiler for ironworks, 640.—Crampton, T. R., Purification of feed water, 640.—Head, Jeremiah, Conversion of ironworks into steelworks, 640; iron rails superseded by steel, 641; iron and steel for shipbuilding, 641.—Bell, I. L., Greater power required for rolling steel than iron, 642; supersession of acid process by basic in manufacture of iron, 642; long cylindrical boiler for ironworks, 643; temperature of products of combustion, 644.—Bennett, P. D., Good iron castings less liable to crack, 644.—Walker, B., Best hard qualities of iron are most liable to crack, 645.—Cowper, E. A., Relative advantages of water-tube and Lancashire boilers, 645; experiments on power for rolling steel and iron, 645; steel for railway sleepers, 646.—Copeland, C. J., Working of ingot cranes, 646; economy and advantages of Turner marine boiler, 647; power for rolling steel and iron rails, 648.—Bell, I. L., Lower temperature in rolling steel rails, 648.

STEEL PLATES, Flanging cold by hydraulic pressure, 1882, 528. *See* Flanging Steel Plates.

STEEL, TEMPERED, *Paper* on the Molecular Rigidity of Tempered Steel, by D. E. Hughes, 1883, 72.—Application of induction balance to molecular constitution of iron and steel, 72.—Apparatus employed, 73.—Effect of torsion upon iron wire, 75.—Torsion is of molecules, not of whole mass, 75.—Molecular rigidity of tempered steel, 76.—Retentive or coercitive force of iron and steel, 77.—Effect of vibration in freeing iron wire from remaining magnetism, 78.—Illustration by means of iron filings in glass bottle, 79.—Hard-drawing does not diminish molecular freedom of iron, 80.—Great physical change produced in iron by carbon alloy, and augmented by tempering, 80.

*Discussion.*—Hughes, D. E., Experiments shown in illustration of subject, 81; difference of molecular condition in two pieces of same metal, 81; great effect of slightest torsion upon iron, 82; induction balance produces effects entirely by electricity, 83; iron filings in bottle lose magnetism when free to move, keep it when held rigid, 83; iron rod loses magnetism under jar or vibration, but steel retains it, 84; weak magnetisation is more retained by iron than by steel, 84; torsion produces greatest effects upon magnetisation of iron, but far less in steel, 85; alloy of carbon necessary for enabling a metal to harden when tempered, 86; molecules in solid iron turn far more freely than loose filings in bottle, 87; scale of rigidity for iron and steel of different hardnesses, 87.—Preece, W. H., Electrical purposes require steel as strongly magnetic as possible, 88; great improvement in strength of steel magnets, 88; Clemendot's process of hardening red-hot steel by compression, 89; strength of Gower magnets suggests improvement of iron, 89.—Bramwell, Sir F. J., What size of steel dealt with in Clemendot's process, 90.—Preece, W. H., Small pieces of steel, pressed between metallic surfaces, 90.—Bramwell, Sir F. J., Hardening probably produced by contact with cold surfaces, 90.—Paget, A., Complete hardening of thin steel by contact with cold iron plates without pressure, 90.—Schönheyder, W., Forging of compressed steel without loss of hardness, 91.—Bramwell, Sir F. J., Effect of oil-tempering on steel, 91.—Kennedy, A. B. W., Do results obtained with wire hardened by drawing hold good for larger specimens not so hardened, 91.—Hughes, D. E., Same results from large bars as from wires, 91; steel sufficiently compressed will retain magnetism without tempering, 92.—Westmacott, P. G. B., Value of paper and experiments, 92.

STEEL WORKS, SIEMENS, Landore, 1874, 241. *See* Landore.

STEEL WORKS, visited at Glasgow meeting; Steel Company of Scotland, 1879, 573.—Visited at Barrow meeting; Barrow Hæmatite Company, 1880, 481-3.—Visited at Summer meeting, Belgium; *see* Iron and Steel Works.

- STEELE'S COMPRESSED-AIR BRAKE for railway trains, 1878, 79, 94.
- STEERING GEAR, HYDRAULIC, 1874, 37.
- STEPHENS, M., elected Member, 1874, 256.
- STEPHENSON, J., elected Graduate, 1874, 257.
- STEPHENSON, J. G. L., elected Graduate, 1879, 38.
- STEPHENSON SAFETY LAMP, 1879, 221. *See* Safety Lamps.
- STERNE, L., elected Member, 1876, 57.
- Steel Boiler Experiments, 1878, 243.
- STÉVART, A., Note on Ateliers de la Meuse Engine Works, 1883, 534.
- STEVENS, A. J., elected Member, 1875, 65.
- Ventilator, Roots' Mine, 1877, 112.
- STEVENSON, G. W., elected Member, 1878, 31.
- STEWART, A., elected Member, 1877, 165.
- Ventilator, Roots' Mine, 1877, 112.
- STEWART, C. P., elected Vice-President, 1875, 34.—1876, 26.—1877, 25.—1878, 29.  
—1879, 36.—1882, 32.—Decease, 1882, 253.—1883, 36.—Memoir, 1883, 27.
- STEWART, D., elected Member, 1878, 108.
- ST. GOTHARD RAILWAY, 1883, 463. *See* Railway, St. Gothard.
- ST. GOTHARD TUNNEL, 1883, 156. *See* Tunnel, St. Gothard.
- STILEMAN, F., Docks, Barrow-in-Furness, 1880, 333.
- STILEMAN, F. C., Docks, Barrow-in-Furness, *Paper* on the Docks and Railway  
Approaches at Barrow-in-Furness, 1880, 324.
- STIRLING, J., elected Member, 1880, 186.
- STOCKTON AND DARLINGTON RAILWAY, original gauge, 1875, 81.
- STOKER, F. W., elected Member, 1875, 189.
- STOKES, A. A., elected Member, 1877, 26.
- STONE-DRESSING MACHINERY, *Paper* on Stone-Dressing Machinery, by J. D.  
Brunton and F. Trier, 1881, 133.—Use of circular rotating cutters to chip  
stone, 133.—Application to turning granite, 134.—Wear by attrition, 134.  
—Principle of driving the cutters independently, 134.—Description of  
revolving chuck and cutters, 135.—Arrangement of cutters in steps,  
136.—Material of cutters for different stones, 137.—Rate of dressing,  
138.—General construction of dressing machine, 138.
- Discussion.*—Trier, F., Travelling tables for bringing up stone, 139;  
play in clutches driving cutters, 140.—Cowper, E. A., Have machines  
been used for millstone grit, 140.—Trier, F., Cast-iron cutters for grit;  
wear and changing of cutters, 140.—Crampton, T. R., Relative cost of  
hand-labour and machine, 141.—Trier, F., Cost reduced to one-third in  
hard gritstone, 141.—Williams, R. P., Will machines dress any but plane  
surfaces, 141.—Trier, F., Turning granite columns, and cutting panels,  
141.—Brunton, J. D., Turning of granite columns, and dressing of  
millstones, 141.—Bale, M. P., Speeds and angles of cutters for different



## STONE DRESSING MACHINERY (continued).

stones, 142; unequal wear of cutters, 142.—Brunton, J. D., Inclination of cutter is  $45^{\circ}$  for all stones, 143; speed, the faster the better, 143; variation in wear of cutters, 143; fine surface produced by machine, 143.—Trier, F., Angles for cutting edge of cutters, 144.—Cole, J. W., Have French burr stones been dressed, 144.—Brunton, J. D., Successful dressing of such stones, 144.

STOREY, J. H., decease, 1884, 3.—Mémor, 72.

STOTHERT, G. K., elected Member, 1877, 299.

STOW FLEXIBLE SHAFT for drilling in any position, 1878, 610.

STREATFEILD, M. A., elected Graduate, 1884, 80.

STRENGTH OF CAST-IRON ENGINE-BEAMS, Experiments, 1882, 531. *See* Beams.

STRENGTH OF SHAFTING, 1883, 182. *See* Shafting.

STRONG, G. S., Feed-Water Heater and Filter, *Paper* on a Feed-Water Heater and Filter for Stationary and Locomotive Boilers, 1881, 539.—Remarks, 545, 550.

STRONGE, C., elected Member, 1884, 2.

STROUDLEY, W., Brakes, Automatic Action, 1880, 137.

Locomotives, Compound, 1883, 459.

STRUCTURE OF CAST-STEEL INGOTS, 1880, 152. *See* Steel, Chernoff's Papers.

STRYPE, W. G., Docks, Barrow-in-Furness, 1880, 330.

STUART, J., elected Associate, 1878, 558.

STURGEON, J., elected Member, 1882, 255.

Accidents, Mine, Mechanical Appliances for, 1877, 342.

SUBAQUEOUS ROCK-BORING MACHINERY, 1875, 104.

SUBJECTS FOR PAPERS. *See* Papers, Subjects for.

SUGAR, *Paper* on the Manufacture of Sugar in Belgium, by A. Melin, 1883, 368.

— Cultivation of beet-root, 369. — Analysis of substances occurring in manufacture, 374. — Products of manufacture, 376. — Operations preliminary to manufacture, 383.—Extraction of juice by hydraulic pressure, 385.—Rasping, 385.—Pressing, 386.—Extraction of juice by diffusion, 389.—Root-cutter, 390.—Diffusion battery, 391.—Slice-presses, Klusemann's, 392; Bergreen's, 393; Selwig and Lange's, 393; Russian pump, 393.—Course of operations in diffusion battery, 393.—Method of taking excise, 396.—Separate rasping works, 397.—Defecation, 398.—Double carbonatation, 400.—Manufacture of lime and carbonic acid, 401.—Treatment of scum, 402.—Filtration, 403.—Revivification of charcoal, 405.—Evaporation of juice, 406.—Advantages of triple-action evaporators, 409.—Boiling, 409.—Centrifugal separation, 412.—Osmosis of molasses, 414.—Tabular analyses showing composition of juice and of products, 416.—Analyses of bye-products, 417.—Mode of valuing sugar, 418.—Statistics, 419.

SUGAR REFINERY, visited at Glasgow meeting; Lyle, Greenock, 1879, 577.

SUGDEN, T., elected Member, 1882, 16.

SUMMER MEETINGS of Institution :—

Cardiff, 1874, 101.

Manchester, 1875, 189.

Birmingham, 1876, 197.

Bristol, 1877, 165.

Paris, 1878, 293.

Glasgow, 1879, 335.

Barrow, 1880, 309.

Newcastle-on-Tyne, 1881, 407.

Leeds, 1882, 251.

Belgium, 1883, 307.

Cardiff, 1884, 197.

SUNDERLAND, Bridges, Docks, and Works, visited at Newcastle meeting, 1881, 615-618.

SUPPLEMENTARY GOVERNOR, 1884, 157. *See* Engine Recorder.

SUTCLIFFE, F. J. R., elected Member, 1875, 65.

SUTTON, J. W., elected Member, 1883, 179.

SUTTON, T., elected Member, 1880, 489.

SWAINE, J., elected Member, 1882, 476.

SWALE, G., elected Graduate, 1883, 34.

SWAN, J. W., elected Member, 1884, 199.

SWAN'S ELECTRIC LIGHT, shown at Newcastle meeting, 1881, 612.

SWIMMING BATH, FLOATING, 1875, 134. *See* Bath, Floating Swimming.

SWINBURNE, W., elected Member, 1882, 255.

SWINGLER, T., decease, 1874, 2.—Memoir, 24.

## T.

TAFF VALE RAILWAY, Locomotive Shops, 1884, 363. Locomotive Running Shed, 1884, 243. *See* Locomotive Running Shed.

TAITE, J. C., elected Member, 1878, 31.

TANDY, J. O'B., elected Member, 1882, 255.

TANGYE, G., elected Member, 1875, 65.

TANNETT, T., decease, 1878, 22.—Memoir, 15.

TARRETT, W., elected Member, 1879, 583.

Petroleum Fuel in Locomotives, 1884, 304.

TATHAM, G., Mayor of Leeds, Welcome to members at Leeds meeting, 1882, 251.

TAUNTON, R. H., elected Member, 1876, 197.

TAYLER, A. J. W., elected Associate, 1882, 476.

TAYLOR, A., elected Graduate, 1874, 257.

TAYLOR, C. D., decease, 1877, 3.—Memoir, 22.

TAYLOR, G., decease, 1876, 3.—Memoir, 24.

TAYLOR, H. E., elected Member, 1874, 27.

TAYLOR, JOHN (London), decease, 1882, 17.—Memoir, 13.

Rock-Drilling Machinery, 1874, 92.

TAYLOR, JOSEPH, elected Graduate, 1884, 2.

TAYLOR, J. S., elected Member, 1875, 36.

TAYLOR, M., elected Graduate, 1884, 199.

TAYLOR, P., elected Member, 1874, 256.

TAYLOR, R., decease, 1884, 3.—Memoir, 73.

Power Transmission, Note on use of flat-rods for, 1881, 100.

TAYLOR, R. H., elected Member, 1882, 255.

TAYLOR, T. A. O., elected Member, 1882, 255.

TAYLOR, W., elected Member, 1883, 310.

TAYLOR, W. C., elected Member, 1877, 72.

TAYLOR, W. H. O., elected Member, 1876, 197.

TAYLOR'S HYDRAULIC PRESS for pressing cotton, 1878, 46.

TELODYNAMIC TRANSMISSION OF POWER by quick-running light wire rope, Hira's system, 1874, 56.

TEMPERING of Steel Boiler Plates, 1878, 226.

TEMPLETON, E. A. S., elected Graduate, 1884, 409.

TENNANT, J., decease, 1879, 22.—Memoir, 17.

TERRE NOIRE WORKS, manufacture and properties of steel, 1880, 173, 175, 182.

TERRY, S. H., elected Member, 1882, 476.

TESTING CURRENT-METERS, *Paper* on the Apparatus used for Testing Current-Meters, at the Admiralty Works at Torquay for experimenting on models of ships, by R. Gordon, 1884, 190.—Description of tank and railway, 190.—Recording and measuring apparatus, 190.—Dynamometer, 191.—Towing arrangement, 191.—Hauling engine, 192.—Froude's governor, 192.—Speedle, 193.—Rate-curves and master curve, 194.—Plan adopted for eliminating errors, 194.

*Discussion.*—Gordon, R., Accuracy and adjustment of governor. 195.

TESTING of iron and steel. *See* Steel Boiler Experiments.

TESTING MACHINE, *Paper* on a Single-Lever Testing Machine, by J. H. Wicksteed, 1882, 384.—Principles of dead-weight testing machines, 384.—Novelties in single-lever testing machine, 386.—Construction of machine, 387.—Clips for holding sample, 387.—Steady motion by hydraulic screw compressor, 388.—Lever, and graduation, 388.—Testing of deflection or compression, 390.—Advantages of single-lever testing machine, 390.

*Discussion.*—Westmacott, P. G. B., Pressure on knife-edges, 391.—Cochrane, C., Rapidity of testing, 391.—Head, J., Belt power for working

## TESTING MACHINE (continued).

machine, 391; shape of clips for holding sample, 391.—Williams, R. Price, Accuracy of machine, 392; mechanical record of extension wanted, 392.—Kitson, J., Jun., Holding of sample by pins or by clips, 392.—Greig, D., Necessity for proper testing, 393.—Adamson, D., Difference between single-lever and multiple-lever testing machine, 393; multiple-lever machine of one thousand powers, 394; speed of testing, 394; grip-box preferable to pins for holding sample, 395; attachment of load too close to fulcrum, 396; method of testing with multiple-lever machine, 396; elongation should be accurately taken, 398; higher limit required for pull, 398.—Walker, B., Practical value of testing machine, 399.—Paget, A., Pins or grip-boxes for holding sample, 399; errors through defective holding, 400; degree of accuracy in measurement of extension, 400; speed of testing, 400.—Halpin, D., Friction in testing machine, 401; diagram-recording apparatus, 401; speed of testing immaterial, 401; necessity of continued testings, 401.—Wicksteed, J. H., Holding sample by pins or by clips, 402; swivelling clips, 403.—Westmacott, P. G. B., Are swivel-boxes lubricated, 403.—Wicksteed, J. H., Lubrication not needed, 403; facility of testing accuracy of machine, 403; speed of testing, 404; relative unrecorded strain in single-lever and in multiple-lever machine, 405; measurement of extension, 405; higher cost of larger testing machine, 405; floating of lever end, 406; diagram-recording apparatus, 407; sensibility of testing machine, 407.—Westmacott, P. G. B., Well-considered piece of mechanism, 407.

THARSIS SULPHUR AND COPPER WORKS, Cardiff, 1884, 366.

THOM, W., elected Member, 1877, 72.

THOMAS, J. L., Power Transmission by Ropes, 1874, 66.

Rock-Drilling Machinery, 1874, 93.

THOMAS, W. H., elected Member, 1874, 256.

Water Meter, *Paper* on Barton and West's piston Water Meter, 1879, 444.

Water Pressure, *Paper* on Barton and West's Water-Pressure Reducer, 1879, 434.

THOMAS' NEEDLE WORKS, Redditch, 1876, 337, 341.

THOMPSON, J., elected Member, 1875, 315.

THOMPSON, R. C., elected Member, 1883, 33.

THOMPSON, T. W., elected Member, 1880, 489.

THOMSON, D., elected Member, 1879, 583.

THOMSON, JAMES, Dredger, Vertical-action, 1879, 557.

Flow round River Bends, 1879, 456.

THOMSON, J. M., elected Member, 1875, 315.

THOMSON'S INDIA-RUBBER TYRES, 1879, 494, 497, 505, 512. *See* Traction Engines.

THOMS, G. E., elected Member, 1875, 315.

THORNBURY, W. H., JUN., elected Member, 1880, 310.

THORNE'S PORTABLE DRILLING MACHINE, 1878, 573.

THORNTON, F. S., decease, 1877, 3.—Memoir, 23.

THORNTON, F. W., elected Member, 1877, 72.

THORNTON, H. R., elected Member, 1882, 16.

THORNYCROFT, J. I., elected Member, 1876, 28.

Bath, Floating Swimming, 1875, 152.

Boiler, Lancashire, 1876, 116.

Rock-Drill, Diamond, 1875, 113.

THOW, W., elected Member, 1882, 255.

THRASHING MACHINES, *Paper* on Thrashing Machines, by W. W. Beaumont, 1881, 369.—Operations performed in thrashing, 370.—Ransomes' machine, 371.—Clayton and Shuttleworth's machine, 377.—Garrett's machine, 379.—Davey Paxman and Co.'s machine, 381.—Gibbons' machine, 382.—Robey's machine, 383.—Other makers, 384.—General constants for thrashing machines, 384.—Constant for shakers, 386.—Constant for caving riddles, 388.—Constant for lower-shoe sieves, 389.—Constant for second-dressing shoe sieves, 390.—Fans, first-blast and second-blast, 390.—Screens, 391.—Driving power required, 391.—Appendix, drum guards, 392.

*Discussion.*—Beaumont, W. W., Steel locking-plates, beaters, drum guards, and coefficients, 396.—Head, Jeremiah, Advantages of thrashing machine over flail, 396; use of fan-blast elevator, 398; iron or steel frames in place of wood, 398.—Rich, W. E., Power consumed in thrashing, 398; uniformity of dimensions in thrashing machines, 399; use of wooden connecting-rods or links, 399.—Cowper, E. A., Effect of diagonal feeding, 399.—Rich, W. E., Different modes of feeding, 400.—Pendred, V., Scientific points connected with thrashing machines, 400; synchronous oscillation for reciprocating shoes, 401; shaking corn by blows, 402.—Beaumont, W. W., Increased number of screenings, 403; fan-blast elevator, 403; substitution of iron or steel for wood in thrashing machines, 403; length of drum, 404; mode of feeding, 405; drum-spindles run cool, 405; length of oscillating hangers, 405.—Cowper, E. A., Weighing corn into sacks, 405.—Beaumont, W. W., Automatic weighing by separate machine, 405.—Cowper, E. A., Elastic wooden connections in place of joints, 406.

THREE-CYLINDER ENGINE, BROTHERHOOD'S, Compressed-Air, 1874, 224.—Hydraulic, 1874, 173, 183, 184.—Steam, 1875, 126, 130.

THWAITES, A. II., elected Member, 1884, 199.

THWAITES, W. H., elected Member, 1875, 315.—Decease, 1883, 36.—Memoir, 28.

TILFOURD, G., elected Associate, 1884, 409.

TIMMINS, S., Watt, Inventions of James Watt, 1883, 625, 630.



TIMMIS, I. A., elected Member, 1884, 199.

Railway Electric Signals, *Paper* on the application of Electro-Magnets to the working of Railway Signals and Points, 1884, 444.—Remarks, 454, 466.

TINA or Vat Process for Amalgamation of Silver Ores, 1884, 257. *See* Silver Ore Amalgamation.

TINPLATE WORKS, Landore, refinery, forge, rolling mill, and preparing and tinning plates, 1874, 246.—Coatbridge, visited at Summer meeting, Glasgow, 1879, 576.—Abercarn, visited at Summer meeting, Cardiff, 1884, 359, 392.

TIPS FOR DISCHARGING COAL, Balance, 1874, 125.—Hydraulic, 1874, 126.

TOBACCO MANUFACTORY, Paris, visit to, 1878, 549.

TOLMÉ, J. H., decease, 1879, 22.—Memoir, 17.

TOMKINS, E., decease, 1877, 3.—Memoir, 23.

TOMKINS, W. S., elected Member, 1875, 65.

Injector, Automatic, 1884, 178.

Petroleum Fuel in Locomotives, 1884, 314.

TOMLINSON, J., elected Member of Council, 1880, 24.—1883, 53.

Brakes, Automatic Action, 1880, 136.

Brake, Automatic Screw-Brake, 1882, 510.

Brakes, Continuous, for railway trains, 1878, 87, 91, 92, 93.

Brakes, Effect of, upon railway trains, 1878, 483.

Compressed-Air Engines for Tramways, 1881, 674, 675.

Docks, Cardiff, 1884, 240.

Locomotive, Brown's Tramway, 1880, 74.

Locomotives, Compound, 1879, 349.

Locomotives, Francq's Fireless, for Tramways, 1879, 629.

Locomotives, Fuel Consumption, 1884, 105, 116, 117.

Locomotive Running Shed, 1884, 253.

Petroleum Fuel in Locomotives, 1884, 299.

TOULON HYDRAULIC MACHINERY, 1878, 346. *See* Hydraulic Machinery, Toulon.

TOWER, B., elected Member, 1883, 33.

Friction, *First Report* on Friction Experiments, 1883, 632.—Remarks, 1884, 29, 34.

TRACTION UPON TRAMWAYS. *See* Tramways, Mechanical Traction, 1878, 395.—Compressed-Air Engines for Tramways, 1881, 649.

TRACTION ENGINES, *Paper* on the working of Traction Engines in India, by R. E. B. Crompton, 1879, 494.—Advantages of rubber-tyred traction engines, 494.—Description of engines used in India, 495.—Wheels, rubber tyres, and shoes, 497.—Tender, fuel, and water, 498.—History of trials, 499.—Prevention of oscillation in rear part of train, 502.—Wrought-iron axle-boxes, 502.—Working cost, 502.—Breakage of crank-shafts and counter-shafts, 504.—Wear of rubber tyres, 505.—Speed and regularity,

## TRACTION ENGINES (continued).

506.—Load, 506.—Anomalous results as to road friction, 508.—Conclusions, 508.—Importance of cheap haulage by traction engines, 509.—Appendix, dimensions of engines, 510.—Working of engines, and analysis of working expenses, 511.—Wear of rubber tyres, 512.—Speeds, 512.

*Discussion.*—Crompton, R. E. B., Cost of transport in India and in England, 513; cost of traction on tramways, 514; advantages of traction engines as against tramways, 515.—Muirhead, R., Mode of discharging exhaust steam, 515; wear of india-rubber tyres, 516; employment of native drivers in India, 516.—Head, Jeremiah, Working of ‘coffee-pot’ shunting engine, 516; mode of discharging exhaust steam, 517.—Crompton, R. E. B., Particulars of blast-pipe, 517.—Brodie, J. S., Wear of driving chains in steam road rollers, 517; cheapest fuel is gas coke, 518.—Buckley, R. B., Great question regarding traction in India is the cost, 518; capabilities of native drivers, 518; cost of different modes of carriage in India, 519.—Losada, Capt., Working of rubber-tyred traction engines in Glasgow, 520; requirements of tramway working, 520; cost of working Glasgow tramways, 522; compressed-air system, 522.—Cowper, E. A., Early history of steam traction upon common roads, 522; differential gearing for turning corners, 523; cost of steam traction in England, 524; prevention of noise from blast-pipe, 524; india-rubber tyres would save wear and tear of engine, 524.—Browne, B. C., Prevention of noise from blast-pipe, 525; means of rendering exhaust steam invisible, 526; cost of goods carriage on tramways, 526; obstacles to use of traction engines, 526.—Hughes, G. D., Durability of exhaust baffle-box, 527; injury to roads by ordinary traction-engine tyres, 527.—Paget, A., Injury to roads owing to bad form of tyres, 528.—Alley, S., Steam traction on Vale of Clyde tramways, 528.—Kennedy, A. B. W., Working of traction engines along country roads in south of Scotland, 528; wear of india-rubber tyres, 529; conditions for advantageous working of traction engines, 529; specially adapted for very heavy haulage, 529.—Chapman, H., Working of rubber-tyred engine in Paris, 530; use of black lead for preventing wear of tyres, 530.—Crompton, R. E. B., Prevention of wear of tyres in India, 530; wear of road quite imperceptible, 530; mode of discharging exhaust-steam, 531; necessity for gearing, and amount of noise, 531; excellence of native drivers, 532; cost of carriage higher through trains being not always full, 532; noise of blast, and durability of baffle-box, 532; wear of rubber tyres, 533; advantages of ditto, 533.

TRADE OF ANTWERP, Notes on, 1883, 557. *See* Antwerp.

TRAFFIC, RAILWAY, Economy of, 1879, 96. *See* Railway Working.

TRAILL, T. W., Riveted Joints, 1881, 264.

TRAMWAYS, Compressed-Air Engines upon Tramways. *See* Compressed Air.

TRAMWAY LOCOMOTIVES. Brown's, 1879, 526, 628, 630.—1880, 44. Franco's Fireless, 1879, 610.—1880, 37. Hughes', 1879, 521, 524, 528, 571, 637.—1880, 57-62. Moncrieff's Compressed-Air, 1879, 522. *See* Tramways, Mechanical Traction. Locomotive, Brown's Tramway. Locomotives, Fireless. Traction Engines. Compressed-Air Engines.

TRAMWAYS, MECHANICAL TRACTION, *Paper* on Mechanical Traction upon Tramways, by A. Mallet, 1878, 395.—Objects aimed at in substituting mechanical power for human or animal labour, 395.—Great difference between applying steam to tramways and to railways, 395.—Resistance of traction on tramways greater than on railways, 396.—Light trains at short intervals necessary for tramways, 396.—Indispensable conditions for a tramway engine, 397.—Secondary conditions for ditto, 397.—Points on which economy may arise in favour of mechanical power as against horses, 398.—Conditions of traction determine which should be used, 398.—Advantage with horses from the great range of power which they can exert, 399.—Question whether stationary or locomotive engines are best, 399.—Tramways worked by ropes, 399.—Tramways worked by compressed-air engines, 401.—Working expenses of Mékarski's system, 403.—Economy as compared with locomotives, 404.—Tramways worked by hot-water engines, 405.—Theory of the action of such engines, 406.—Tramways worked direct by steam engines, 409.—Comparison between automatic cars and separate engines, 410.—Tramway engines as employed in France, 411.—In Belgium, 414.—In Switzerland, 415.—In Germany, 415.—General conditions and results, 416.—Working expenses of tramway locomotive, 418.

*Discussion.*—Jakeman, C. J. W., Reason for lightness of first Merryweather engines in Paris, 420.—Tresca, H., Question whether driving power should form part of tramcar or be a separate engine, 420; experiments on coefficient of traction, 421; construction of road very important, 422.—Brown, C., Separate engine is best where the gradients are heavy, 422; much depends upon state and class of rail, 423; description of Marsillon's rail, 423.—Hughes, H., Locomotive type best for tramway engines, 423; question is one of cost, 424; working expenses at Glasgow, 424; particulars of engine used there, 425; no advantage in compressed air over steam, 426.—Robinson, J., Not so much dust in Glasgow as in Paris, 426.—Paget, A., Mr. Hughes' method of condensing steam and using no blast, 426.—Hughes, H., No difficulty has been found in condensation, 427.—Bell, I. L., Condensing arrangement at Leeds, 427.—Hughes, H., Method of condensation, 428.—Ross, J. A. G., Method of working by combination of hydraulic system and compressed-air system, 428.—Crompton, R. E. B., Experience with traction engines worked in India, 430; heavy item for repairs on account of dust, 430;

# TRAMWAYS, MECHANICAL TRACTION (continued).

essential for tramway engines that their first cost should be reduced, 431.—Head, Jeremiah, Peculiarity in construction of bearings in engines built by Mr. Hughes, 432.—Hughes, H., Engine travels 75 miles per day regularly in Glasgow, 432.—Williams, R. P., Comparison between working expenses of different systems, 432.—Greig, D., Cost of construction too great at present, 433; weight of engine too light, 434.—Markham, C., Difficulty as to permanent way might be avoided by adopting Barlow rail, 434.—Holt, W. L., General requirements for good tramway engine, 434; better rails wanted, 435; experience of working tramways in Paris, 435; condenser not found necessary, 436; detached engine preferable to combined car, 437.—Hind, H., Difficulties as to wear and prime cost could be easily overcome, 437.—Mallet, A., Question of combined or independent engine, 437; injurious action of dust, 438; construction of tramways in Stuttgart and Strasburg, 439.—Robinson, J., Paper contains a useful base for future operations, 439.

TRAMWAYS, PERMANENT WAY, *Paper* on Permanent Way for street Tramways, with special reference to steam traction, by J. D. Larsen, 1880, 188.—Origin and growth of London tramways, 188.—Difficulty in applying steam traction, 189.—Early systems of laying tramways, 190.—Larsen's rails and side fasteners, 192.—Screw cramp for fixing side fasteners, 193.—McNeale's side fasteners, 193.—Sections of rails for Paris tramways, 193.—Larsen's improved system for steam traction, 194.—Barker's system, 197.—Gowan's, 197.—Aldred's, 198.—Winby's, 198.—Wear of flange in tramcar wheels, 199.—Mackisson's system, 199.—General conclusions, 200.—Cost of different systems of permanent way, 201.—Tractive resistance on tramways, 202.

*Discussion.*—Lynde, J. G., Comparative cost of tramways, 203; rigidity necessary in permanent way, 203; advantage of continuous cast-iron sleeper, 204; material and laying of rails, 205; prices of Barker's permanent way, 206.—Rapier, R. C., Best construction should be preferred, irrespective of cost, 206; desirability of wider rail-surface, 207; compressed-air and hot-water engines for tramways, 208.—Robinson, J., Danger of horses slipping on wide rails, 208; advantages of Barker's system, 209; inadequacy of Paris tramways for steam traction, 209; engines should have short wheel-base and all wheels coupled, 210; higher frictional resistance on tramways than on railways, 210.—Rapier, R. C., Tramrail should be at least as wide as shoe of horse, 210; iron surface less slippery than granite, 211.—Paget, A., Iron surface more slippery than granite, 211.—Rapier, R. C., Absence of slipping on wide tramrails in Glasgow, 211; description and cost of Glasgow tramways, 211.—Crampton, T. R., Solid bottom necessary for tramroad, 212; advantages of Barker's system as compared

## TRAMWAYS, PERMANENT WAY (continued).

with Larsen's, 212; narrower gauge to be preferred for tramways, 213.—Holt, W. L., Difficulties of steam traction in Paris, 213; wider rail wanted for steam than for horse traction, 213; advantage of Winby's system, 214.—Head, Jeremiah, Elasticity on railways obtained by Wood's wrought-iron cross sleepers, 214; not so much a question of material as of form, 215; wooden sleepers inferior to iron, 215.—Winby, F. C., Section of tramrail and method of rolling, 215; separate head now unnecessary for grooved rail, 216; 3 ft. gauge sufficient for tramways, 217; elasticity unnecessary in tramway, 217; length of tramway laid in one piece, 217; width of rails, grooves, and wheel flanges, 217; tramways as laid in Nottingham, 217.—Williams, R. P., Endurance of tramways under steam traction, 218; resistance to traction on tramways, 219; elasticity essential for durability, 219.—Robinson, J., What was the section of tramrail which gave high tractive resistance, 219.—Cowper, C. E., Disadvantage of horses stepping from street pavement to wide tramrail, 220.—Schönheyder, W., How is paving brought close up to tramrail, 220.—Winby, F. C., Stone setts packed up underneath with sand, 220.—Cowper, E. A., Shocks from heavy weights passing *across* tramrail, 220; grooves too wide in rails, 221; thin steel flanges for wheels, 221.—Lynde, J. G., Flanges of Barker rails not broken, 221.—Larsen, J. D., Best tramways he had seen were in Manchester, 221; only objection to Barker's system was the cast-iron sleepers, 222; width and depth of groove in tramrails, 222; first cost of tramways, 222; number of wheels for tramway engines, 222; foundation below sleepers, 223; advantage of separate rail head, 223.

TRANSMISSION OF POWER. *See* Power Transmission. *See* Rope Gearing.

TRANSPORT, CHEAP INTERNAL, 1879, 399.—1882, 260.

TRASENSTER, L., nominated Honorary Life Member, 1883, 310 :—acknowledgment, 311.

Railway, St. Gothard, 1883, 491.

Vote of thanks to President for address, 1883, 308.

TRASENSTER, P., Belgian Railways, Notes on, 1883, 586.

TREASURER, election of, and vote of thanks to late Treasurer, 1878, 560.

TRENTHAM, W. H., elected Member, 1883, 180.

TRESCA, H., Boiler Feeder, Letter on Fromentin Automatic Boiler Feeder, 1882, 486.

Electricity for Coal Mining, 1882, 432.

Flow of Solids, *Paper* on further applications of the Flow of Solids, 1878, 301.—Remarks, 338.

Gas Engines, Experiments on Explosive Mixtures in Gas Engines, 1875, 205, 216.

Tramways, Mechanical Traction, 1878, 420.



TREVITHICK, R. F., elected Member, 1876, 28.

TREVITHICK'S COMPOUND ENGINE, 1874, 265.

TRIER, F., Stone-Dressing Machinery. *Paper* on Stone-Dressing Machinery, 1881, 133.—Remarks, 139, 140, 141, 144.

TROEDYRMEW, CRAWSHAY'S CASTLE PIT, large pumping and winding engines, 1874, 238.

TROWARD, C., decease, 1874, 2.—Memoir, 25.

TUBE WORKS, Wednesbury, 1876, 339.

TUCK'S PACKING, for piston of steam accumulator, 1874, 50.

TUNNEL-BORING MACHINERY. *See* Rock-Drill. Mining Machinery. Tunnel, *below*.

TUNNEL, CHANNEL, *Lecture* on an Automatic Hydraulic system for Excavating the Channel Tunnel, by T. R. Crampton, 1882, 440.—Excavation by boring, 440.—Rate of boring in chalk, 441.—Removal of debris, 441.—Lining of tunnel, 442.—Automatic hydraulic system, 442.—Hydraulic transmission of power, and removal of sludge, 443.—Cutting machinery, 444.—Reduction of debris to sludge, 446.—Removal of sludge, 447.—Power required, 448.—Alternative scheme where tunnel has sufficient fall for drainage, 449.—Smaller power required, 450.

TUNNEL, SEVERN. *See* Rock-Drilling Machinery, 1877, 206.—Visited at Summer meeting, Cardiff, 1884, 359, 395-397.

TUNNEL, ST. GOTHARD, *Paper* on the St. Gothard Tunnel, by E. Wendelstein, 1883, 156.—General design, 156.—Alternative schemes, 157.—Method of driving the tunnel, 158.—Rocks passed through, 159.—Motive power for driving, 160.—Air-compressors, 162.—Cooling of air during compression, 162.—Boring machines, 164.—Removal of spoil, 166.—Compressed-air locomotives, 167.—Dimensions of engines, 169.—Cost of tunnel, 169.—General conclusions, 170.—Superior limit to level for tunnel, 171.—Mode of driving by top heading or bottom heading, 172.—Influence of mode of driving upon completion of tunnel, 172; upon power of keeping back the pressure of soft rock, 174; upon cost of construction, 174.—Contract price at Arlberg tunnel and at St. Gothard, 175.

*Discussion*.—Wendelstein, E., Experience from St. Gothard tunnel, useful for other long tunnels in progress or contemplated, 176.—Rennie, G. B., Letter from Herr Dapples, 176.—Wendelstein, E., Note on letter, 177.

TURBINES, at Schaffhausen, 1874, 61.—Application of helical pump, 1874, 281.

TURNBULL, C. H., elected Member, 1883, 180.

TURNER, A. H., elected Member, 1884, 409.

TURNER, F., Expansion Gear, Automatic, 1882, 431.

TURNER, T., elected Member, 1882, 476.

TURNERY, J., elected Member, 1876, 197.

TURNING AND PLANING, principles of, 1878, 321.

TUYERE, OPEN SPRAY, *Paper* on the Open Spray Tuyere and other blast-furnace tuyeres, by F. H. Lloyd, 1876, 350.—Various tuyeres used, 350.—Coiled tuyere, 350.—Water-jacketed tuyeres, 350.—Different metals used, 351.—Description of open spray tuyere, 351.—Action of spray pipes, 352.—No increase of water required, 353.—Greater durability of tuyeres, 353.—No water can enter the furnace, 353.—Causes of injury to water tuyeres 354.—Difficulty of detecting leakage with ordinary tuyeres, 354.—Cause of accidents with water-jacketed tuyeres, 354.—Arrangement for detecting leakage, 356.—Remedy for incrustation with open spray tuyere, 357.—Damaged tuyere need not be removed hastily, 357.—Sizes of spray tuyeres in use, 358.

*Discussion.*—Lloyd, F. H., Specimens of spray tuyeres, 359.—Cochrane, C., Advantage in removing danger of ordinary tuyeres, 359; difficulty of perfect weld in jacketed tuyere, 359; means of detecting leakage, 360; danger of explosion with water-jacketed tuyere, 360; prevention of cooling of blast by tuyere, 361; means of preventing stoppage of spray pipes, 361.—Adamson, D., Disastrous explosions caused by ordinary tuyeres, 362; protection afforded by spray tuyere, 363; arrangement of holes in spray pipes, 363; means of preventing cooling of blast by tuyere, 363; advantages of spray tuyere, 364; means of easily detecting leakage, 364.—Hawksley, C., Application of platinum tuyere, 365.—Webb, F. W., Application of spray tuyere to cupolas, 365.—Cowper, E. A., Small head of water required for supply of spray tuyere, 366; spray of water could keep cool a surface exposed to fire, 367.—Head, J., Means of working cupolas continuously night and day, 367.—Lloyd, F. H., Causes of explosions with ordinary tuyeres, 368; arrangement of spray pipes, 368; prevention of obstruction in pipes, 369; application of spray tuyeres to cupolas, 370.—Webb, F. W., Cupolas required to work continuously for a week, 370.—Lloyd, F. H., Malleable cast-iron for tuyeres, 371; small pressure of water best for spray tuyeres, 372.—Cowper, E. A., Pressure can be regulated by cock on supply pipe, 371.

TUYERES, distance apart in blast-furnace. *See* Blast-Furnace Working.

TWEDDELL, R. H., elected Member of Council, 1883, 53.

Accidents, Mine, Mechanical Appliances for, 1877, 335.

Docks, Cardiff, 1874, 138.

Gas Engine, Atmospheric, 1875, 210.

Gauge, Standard, for High Pressures, 1880, 474.

High-Pressure Vessels, 1878, 277, 278, 286.

Hydraulic Machinery, Marine, 1874, 46, 53.

Hydraulic Machinery, Toulon, 1878, 377, 378, 379, 381, 382, 390.

Hydraulic Machinery, Workshop, *Paper* on the application of Water

TWEDDELL, R. H. (continued).

Pressure to driving machinery and working shop tools, 1874, 166.—  
Remarks, 176, 195.

Injector Hydrants, 1879, 388.

Iron and Steel for Boilers, 1879, 317.

Lifts, Hydraulic, 1882, 160.

Patent Laws, 1875, 183.—1876, 179.

Power Transmission by Ropes, 1874, 68.

President, election, 1878, 33.

Presses, Hydraulic Packing, 1877, 365.—1878, 45.

Pressure-Intensifying Apparatus, *Paper* on the Application of direct-acting  
Pressure-Intensifying Apparatus to Hydraulic Presses, 1878, 45.—  
Remarks, 64.

Research, Mechanical, 1879, 49.

Riveted Joints, 1881, 258.—*Table* showing rules of practice for Riveted  
Joints, 1881, 293-299.

Rock-Drill, Diamond, 1875, 113.

Rock-Drilling Machinery, 1874, 95.

Rules, 1876, 31.—1880, 35.

Saw, Direct-Acting Circular, 1875, 132.

South-Wales Mineral Wagons, 1884, 433.

Steel Boiler Experiments, 1878, 237-241, 265-266.

Steel Compression by Steam, 1880, 415.

Water-Power Engines, 1879, 489.

Water-Pressure Mining Engines, 1880, 258, 261.

TWEEDY, J., elected Member, 1882, 146.

TWIBILL, J., elected Member, 1874, 27.

TYLER, SIR H., Brakes, Effect of, upon railway trains, 1879, 208. }  
Brakes, Automatic Action, 1880, 128-132.

TYLOR, J. J., elected Member, 1877, 299.

Accidents, Mine, Mechanical Appliances for, 1874, 324.

Water Meters, *Paper* on Meters for registering Small Flows of Water,  
1882, 41.—Remarks, 64, 92.

TYNE, *Paper* on the Tyne as connected with the History of Engineering, by  
I. Lowthian Bell, 1881, 425.—Froude's disparagement of engineering skill,  
425.—Refutation by discoveries resulting from profound research, 426.—  
Condition of Tyne district anterior to present century, 428.—Output of  
coal, mode of mining, pumping engines, 429.—Tubbing of shafts, and  
sinking through water-bearing strata, 430.—Condensing and non-  
condensing engines, 431.—Coking, 431.—Ventilation of collieries, and  
safety lamp, 432.—Coal-cutting machines, 433.—Origin of railroads, 434.  
—Early locomotives, 435.—Iron shipbuilding, 436.—Iron manufacture,

## TYNE (continued).

438.—Steel manufacture, 441.—Lead and copper works, 441.—Machinery making, 442.—Hydraulic machinery, 442.—Armour plates, and guns, 443.—Electric lighting, 444.—Soda manufacture, 445.—Glass making, pottery, and fire-clay, 446.—River navigation improvements, 447.

TYNE IMPROVEMENTS, inspected at Newcastle meeting, 1881, 611, 612.

TYNESIDE ENGINE WORKS, Cardiff, 1884, 361.

TYNEWYDD COLLIERY INUNDATION, *Paper* on the Tynewydd Colliery Inundation, with particulars of the appliances used for rescuing the miners and recovering the workings, by T. H. Riches, 1877, 221.—Description of the inundation, 221.—Means available for pumping out the water, 222.—Special apparatus designed for boring to the imprisoned miners, 224.—Description of boring apparatus with food carriages, 225.—Total water raised from inundated workings, 226.

*Discussion.*—Riches, T. H., Boring apparatus now in regular use at a neighbouring colliery, 227.—Cowper, E. A., Important for boring apparatus to be provided at every colliery, 227.—Geach, J. J., Method of removing core from borer, 228.—Rich, W. E., Risk of depending on dial pressure gauge in similar cases, 229.—Browne, W. R., Essential thing was to effect a rescue without reducing pressure of air in workings, 229.—Marten, E. B., Diving apparatus, why unsuccessful, 229.—Cowper, E. A., Air-lock devised by Mr. Upward, 230.—Hawksley, C., Escape of air round boring bar, how prevented, 230.—Steel, T. D., Time wasted by attempted employment of diving apparatus, 230.—Morgans, T., Transmission of food carriers, 230; no necessity for all collieries to be provided with special boring apparatus, 231.—Paget, A., Return of empty food carriers, 231; special boring apparatus might be provided for each district, 231.—Jordan, H. K., Desirable for bore-hole to be large enough for men to pass through, 232.—Braham, P., Increased cost and difficulty of boring larger hole, 232.—Riches, T. H., Core in boring tube blown out as dust, 233; failure of air-doors from defective fixing in heading, 233; divers required to be used to underground work, 234; objection to large air-lock from difficulty of getting power enough down into a colliery, 234; mode of sending food-carriers through the boring tube, 235.

TYSON, J. O., elected Member, 1878, 108.

## U.

UNDERGROUND HAULAGE. *See* Compressed-Air Machinery for Underground Haulage, 1874, 204.

UNIVERSAL ROLLING MILL for Plates, 1880, 84. *See* Plate Rolling Machinery.

UNIVERSITY COLLEGE, Nottingham, visited at Autumn meeting, 1884, 414.

UNSWORTH, T., elected Member, 1875, 315.

USWIX, W. C., elected Member, 1878, 31.

Brakes, Continuous, for railway trains, 1878, 88.

Governors, 1879, 417.

Iron and Steel for Boilers, 1879, 306, 314.

Riveted Joints, 1881, 283.—*First Report* on the form of Riveted Joints, 1881, 301-368.

Shafting, Strength of, 1883, 211, 224.

URQUHART, T., elected Member, 1875, 189.

Petroleum Fuel in Locomotives, *Paper* on the use of Petroleum Refuse as Fuel in Locomotives, 1884, 272.—Remarks, 320.

## V.

VACUUM BRAKE for railway trains, Smith-Hardy, 1878, 71, 87, 484, 554, 592-607, 622, 624, 630.—Sanders' automatic, 1878, 79. *See* Brakes.

VALON, W. A. M., elected Member, 1880, 310.

VAL ST. LAMBERT GLASS WORKS, visited at Summer meeting, Belgium, 1883, 513.—Note on Works, 544.

VALVES, for air-compressing cylinders, 1874, 206, 216, 222, 226, 228, 229.—Disc-valves for hydraulic cylinders, 1874, 47, 49, 52, 53, 182.—Pump-valves, 1874, 269.—Slide-valves for steam cylinders, 1874, 264, 265.

VALVE, CIRCULAR SLIDE-, *Paper* on an improved form of Slide-Valve for steam and hydraulic engines, by F. W. Webb, 1877, 197.—Difficulty from grooving action with ordinary slide-valve and port face, 197.—Grooving action effectually prevented by rotation of circular valve in buckle, 197.—Circular slide-valve applied to outside-cylinder locomotive, 198.—Back packing ring for taking off pressure, 198.—Circular slide-valve for inside-cylinder locomotives, 199.—Application to hydraulic capstan engines, found extremely useful, 199.—Application to Brotherhood's direct-acting three-cylinder capstan, 199.

*Discussion*.—Webb, F. W., Successful results of working, 200.—Wilson, J. C., Good construction for preventing grooving, 201.—Walker, B., Cylindrical piston-valve found very successful with high-pressure steam, 201.—Westmacott, P. G. B., Good working of ordinary valves in hydraulic engines, 202; trunnion valve now preferred, 203.—Webb, F. W., Mixture of metal used for valves of hydraulic capstans, 203.—Platt, J., Another form of circular slide-valve under hydraulic pressure not found satisfactory, 204.—Cowper, E. A., Insufficient bearing surface caused valve to seize, 204.—Kelson, F. C., Free opening of exhaust port, 205.—Webb, F. W.,



## VALVE, CIRCULAR SLIDE- (continued).

Wire-drawing no greater with circular slide-valve than with ordinary rectangular valve, 205.

VALVE-GEAR, JOY'S, *Paper on a new reversing and expansive Valve-Gear*, by D. Joy, 1880, 418.—Gray's valve-motion for locomotives, 418.—Link motion, 419.—Other valve-gears, 420.—Description of new valve-gear, 421.—Constant lead for forward and backward motion, and for all grades of expansion, 422.—Application to marine, horizontal, and locomotive engines, 424.—Advantages of new gear, 424.—Greater correctness of new gear, 425.—Total pressures in up and down stroke of vertical engine, 426.—Examination of valve-path diagrams, 426.—Higher grades of expansion, 428.—Greater accessibility of new gear, 428.—Whole gear is always in useful action, 428.—Facility of repairs, 429.—Greater ease of reversing, 429.

*Discussion.*—Marshall, F. C., Description and advantage of his own valve-gear, 430; indicator diagrams, 431.—Webb, F. W., Application of Joy's gear to goods locomotive, 432; indicator diagrams, 432; Trick or Allen slide-valve, 432; improvements in details of engine, 433; fire-box, foot-plates, &c., 434; desirability of uniform dimensions in engines, 434.—Cowper, E. A., Whether any twist from longer bearings, 434.—Webb, F. W., Easing of bushes and brasses allows ample play, 435.—Kitson, J. H., Modification of Walschaert valve-gear for steam tramcar, 435.—Humphrys, J., Advantages of Joy's valve-gear, 436; application to marine engines, 437.—Boyd, W., Practical objection to taking motion from connecting-rod in marine engine, 438; unsteady motion of levers and links, 438; too great sliding motion of valve-block, 439.—Robinson, J., Great wear of block sliding in slot, 439; pins objectionable for oscillating motion, 440.—Paget, A., Comparative travel of sliding block and of eccentric, 440.—Boyd, W., Circular motion of eccentric is preferable to reciprocating motion, 440.—Webb, F. W., Comparative travel of eccentrics and of sliding block, 440; number of pins, 441.—Head, Jeremiah, Comparison with box-link, 441; oblique thrust in Joy's gear, 441; facility of replacing worn parts by duplicates, 442; eccentrics disadvantageous when large, 442; adjustment in Joy's gear to compensate for wear, 443; extent of steam admission in mid-gear, 443.—Siemens, C. W., Important advantages of Joy's motion, 444; swing-link preferable to slide-block, 445.—Reynolds, E., Former proposed arrangement of valve-gear, 445; Hawthorn's and Hackworth's motions, 445.—Marshall, F. C., Sliding motion hindered success of Hackworth's gear, 446; serious wear of connecting-rod ends in marine engines, 446.—Cowper, E. A., Ericsson's valve-motion, 446; problem to combine longitudinal motion for lead, with side motion for travel, 447; Hackworth's and Hawthorn's gears, 447; Joy's gear with sliding block, and with vibrating link, 447; inconvenience

## VALVE-GEAR, JOY'S (continued).

of attachment to connecting-rod, 448; advantage of ample room for bearings, 448; reduction of compression by cutting out inside of slide-valve, 448.—Joy, D., In Marshall's gear only one eccentric removed, and engine-room not shortened, 449; uncorrected errors in gear, compensated by double port at top end, 450; inappreciable effect of wear in connecting-rod upon motion of valve, 451; replacing of worn bushes and pins, 452; less movement in links of new gear than in air-pump lever gear, 452; wear from sliding of block, 452; substitution of radius links, 452; wear less than of eccentrics or slide-bars, 453; precedent in slide-valves for oscillating marine engines, 453; ease of reversing with new gear, 453; Reynolds' gear, 453; distinctive features of Brown's and Hackworth's gears, 454; even wear from end to end of slot in new gear, 454.

## VALVE-GEARS:—

Box-link, 1880, 441.

Brown's, 1880, 46, 48, 445, 446, 454.

Davey's Differential, 1874, 261, 271, 275, 279.

Ericsson's, 1880, 446.

Hackworth's, 1880, 430, 445, 446, 447, 450, 454.

Hawthorn's, 1880, 445, 447.

Joy's, 1880, 418, 480.

Kitson's, 1880, 435.

Marshall's, 1880, 430, 439, 449.

Meyer's, 1877, 287, 288, 290.

Reynolds', 1880, 445, 453.

Rider's, 1877, 280, 293, 294.

Trick or Allen Slide-Valve, 1880, 432, 448.

Walschaert's, 1880, 435.

VALVE, Reducing, for Steam Pressure, 1879, 337, 613. For Water Pressure, 1879, 423, 434. *See* Water Pressure.

VALVES of hydraulic presses, wear of, 1878, 58.

VALVES, SAFETY, *Paper* on the construction of Safety Valves, by J. C. Wilson, 1877, 176.—Defects in action of ordinary safety valves, 176.—Defects in dead-weight safety valve, 177.—Naylor's safety valve, 178.—Ramsbottom's valve, 179.—Principles to regulate construction of safety valves, 179.—Valve ought to be always exposed to full boiler-pressure, 180.—Description of Klotz safety valve, 180.—Result of experiments, 181.—Advantage of Klotz valve for preventing rise of pressure in boiler, 181.

*Discussion.*—Webb, F. W., Danger of valves being tampered with, 182.—Olrick, L., Two or three smaller valves better than one large valve of same total area, 183; description of "Paragon" safety valve, 184.—Chapman, H., Probable inconvenience from corrosion, 185.—Cowper, E. A.,

## VALVE, SAFETY (continued).

Flat seated and winged valves very objectionable, 186; comparison of Klotz valve and common valve, 186.—Hartnell, W., Only small rise of pressure found with ordinary safety valve when well made, 187.—Webb, F. W., Size of opening sufficient to prevent any rise of pressure in locomotive boiler when hard fired, 187.—Paget, A., Satisfactory working of ordinary safety valves when properly made, 187.—Richardson, W., Sudden access of steam pressure in boiler on starting engine, 188.—Hughes, G. D., Safety valve should provide both for excess of pressure, and for deficiency of water, 189; danger from liability to sticking, 189.—Adams, T., Relative expansion of brass and cast iron, 190; ordinary safety valve could not be regarded as free from danger, 191; force, resistance, and motion should all lie in the same straight line, 191; double conical spring objectionable, 191; Ramsbottom valve should have spring attachment slightly below the points of studs, 192; best proportions for construction of helical springs, 192.—Marten, E. B., Objection to too large a safety valve, 193.—Wilson, J. C., Klotz valve could not be jammed, 194; not affected by priming, 194; undesirable to have large safety valves, 194; bell of Klotz valve better guide than centre pin or feathers, 195; construction of spring, 196.

VALVES, SAFETY, Bodmer, 1877, 183; Cowburn, 178; Dead-weight, 177; Klotz, 180; Naylor, 178, 183; Ordinary, 176; Paragon, 184; Ramsbottom, 179.

VAN HOUTTE'S NURSERY GARDENS, visited at Summer meeting, Belgium 1883 517.—Description, 567.

VAPART DISINTEGRATOR, 1878, 490. *See* Disintegrator, Vapart.

VARIABLE AUTOMATIC EXPANSION, 1877, 276. *See* Expansion, Variable Automatic.

VELOMETER GOVERNOR, 1879, 410. *See* Governor.

VENTILATORS FOR MINES, MECHANICAL, *Paper on Mechanical Ventilators for Mines*, by W. Daniel, 1875, 317.—Ventilation of mines by furnaces, both expensive and dangerous, 317.—Extensive adoption of mechanical ventilators, 317.—Fuel consumption compared with furnaces, 318.—Two classes of mechanical ventilators, 318.—Cooke's ventilator, description, 318.—Means of measuring useful effect, 319.—Experiments with different ventilators, 320.—Variation in velocity of air in different positions in the same air-way, 321.—Correct measurement of velocity of air, 321.—Table of velocities of air in different portions of drift, 323.—Table of results of ventilator experiments, 324.

*Discussion.*—Daniel, W., Anemometers used in experiments, 326.—Carbutt, E. H., Displacement ventilator correct principle for deep mines, 326; less expensive ventilator required for shallow mines, 326.—Welch, E. J. C., Method of determining curve at end of shutter, 327.—Paget, A., Amount of windage between drum and shutter, 327.—Cowper, E. A.,

## VENTILATORS FOR MINES, MECHANICAL (continued).

Vibrating shutter a great improvement, 327; small friction in working of machine because no rubbing, 328; principle of ventilator better than fan, 328.—Deacon, G. F., Anemometers liable to fail at low velocities, 328.—Hall, W. S., Percentage of duty in Rammell fan, 328.—Steavenson, A. L., Principle of varying capacity superior to centrifugal action for ventilator, 329.—Head, J., Means of preventing leakage, 330.—Cooke, J., Advantage of varying-capacity ventilator over centrifugal fans, 330.—Daniel, W., Amount of clearance between drum and casing and vibrating shutter, 331; comparative cost of ventilators, 331.—Ramsbottom, J., Advantage in having a definite volume of air at each revolution, 332; means of ascertaining amount of leakage, 332; higher result of useful effect obtained by ventilator than by fan, 332.

VENTILATOR, Greindl rotary, 1878, 462.

VENTILATOR, ROOTS' MINE, *Paper* on Roots' Mine Ventilator and other applications of Roots' blower, by E. H. Carbutt, 1877, 92.—Principle of blower, 92.—Successful applications to different purposes, 93.—Forms of rotating pistons, 93.—Description of ventilator for mines, 95.—Quantity of air displaced, 97.—Comparative results of different ventilators, 98.—Advantage of Roots' blower as an exhauster, 98.—Different constructions of blowers, 99.—Engine for driving blower, 100.—Special chemical blower and exhauster, 101.—Gas exhauster, 102.—Large wearing surfaces and accurately pitched wheels, 103.—Moderate speed of blowers compared with fans, 103.—Tables of experiments on Roots' mine ventilator at Chilton Colliery, Ferryhill, 104.

*Discussion.*—Cochrane, C., Application of blower to sand-blast process, 107; ventilator not more effective than others, when air-doors get disarranged in a mine, 107.—Adamson, D., Advantage in forcing large quantity of air at slow velocity, 107; cast-iron revolvers more enduring and less liable to get out of order than wood, 108.—Head, J., Roots' blower used for blowing cupola, 108; advantage of combined engine and blower on one bed-plate, 109.—Richardson, W., Blowers found preferable to fans for cupolas &c., 109; very desirable for mine ventilation, if could be made to answer as a ventilator, 110.—Perkins, L., Blower with wood revolvers answered well, 110.—Welch, E. J. C., Self-acting regulating cylinder for pressure in blower, 110.—Allan, G., Iron revolvers of blowers if made accurately must be much preferable to wood, 111.—Stevens, A. J., Difficulties in use of Roots' blower as a mine ventilator, 112.—Stewart, A., Experiments with ventilator at Chilton colliery, 112; greater exhaustive power obtained, 113; materials used for construction of revolvers in Roots' blowers, 113; weight of ventilator at Chilton colliery, 114; use of gear for driving, 114; cost of ventilator and engines at Chilton colliery, 115.

VENTILATORS for Mines. *See also* Mining Machinery.

VERVIERS WOOLLEN MANUFACTORIES, visited at Summer meeting, Belgium, 1883, 515.—Notes on Works, 546.

VIAL, E. DE, elected Associate, 1877, 72.

VICTORIA FLOATING DOCK, 1878, 139. *See* Dock, Victoria Floating.

VIEILLE MONTAGNE ZINC WORKS, 1883, 349. Visited at Summer meeting, Belgium, 1883, 513.

VOTE TO LATE SECRETARY, 1878, 20, 27, 108. *See* Secretary.

VOTES OF THANKS :—

1874, at Summer meeting, Cardiff, 233.

1875, to Institution of Civil Engineers, 162 :—at Summer meeting, Manchester, 305.

1876, to Institution of Civil Engineers, 177 :—to Society of Arts, 196 :—at Summer meeting, Birmingham, 327.

1877, to Institution of Civil Engineers, 163 :—to President, 175 :—at Summer meeting, Bristol, 295.

1878, to Institution of Civil Engineers, 291 :—at Summer meeting, Paris, 545.

1879, to Institution of Civil Engineers, 153, 265, 394 :—at Summer meeting, Glasgow, 563.

1880, to Research Committee and Honorary Reporters, 23 :—to Retiring President, 26, 27 :—to Institution of Civil Engineers, 151, 285 :—to President, 320 :—at Summer meeting, Barrow, 476.

1881, to Institution of Civil Engineers, 33, 165 :—to President, 410, 424 :—at Summer meeting, Newcastle, 412.

1882, to Institution of Civil Engineers, 40, 151 :—to President, 256 :—at Summer meeting, Leeds, 253.

1883, to Institution of Civil Engineers, 55, 181 :—to President, 308 :—at Summer meeting, Belgium, 313 :—at Autumn meeting, Birmingham, 597, 631.

1884, to Institution of Civil Engineers, 27, 81 :—at Summer meeting, Cardiff, 200 :—to President, 223 :—at Autumn meeting, Nottingham, 413.

## W.

WADDELL, J., elected Member, 1883, 33.

WADDINGTON, J., JUN., elected Graduate, 1878, 108.

WADDLE, J. R., Engines, Winding, Direct-Acting, 1875, 244.

WADHAM, E., Barrow meeting, Welcome to members at, 1880, 309.—Luncheon to members, 478.

Mines, Furness Iron, 1880, 363, 371, 372.

Vote of thanks to, 1880, 476.



- WADIA, N. N., elected Member, 1879, 155.
- WAGONS, SOUTH-WALES MINERAL, 1884, 415. *See* South-Wales Mineral Wagons.
- WAILES, G. H., elected Graduate, 1882, 146.
- WAILES, J. W., elected Member, 1875, 36.
- WAILES, T. W., elected Member, 1884, 199.
- WAKE, H. H., elected Member, 1881, 409.  
Sunderland Docks, 1881, 617.
- WAKEFIELD, J., decease, 1883, 36.—Memoir, 28.
- WAKEFIELD, W., elected Member, 1882, 255.
- WALKER, A. H., elected Graduate, 1875, 36.
- WALKER, A. T., Water Meters, 1882, 98.
- WALKER, B., Boiler, Lancashire, 1876, 97, 99.  
Compressed-Air Machinery, 1874, 221, 222.  
Compressed-Air Engines for Tramways, 1881, 676.  
Docks, Cardiff, 1874, 139, 140 :—1884, 239.  
Docks, Pumping Machinery, 1874, 159.  
Engines, Winding, Direct-Acting, 1875, 234.  
Hydraulic Machinery, Marine, 1874, 44.  
Hydraulic Machinery, Workshop, 1874, 190.  
Lifts, Hydraulic, 1882, 152.  
Mining Machinery, 1882, 367.  
Presses, Hydraulic Packing, 1877, 361.  
Steel Plant, Bessemer, 1881, 632, 637, 645.  
Testing Machine, Single-Lever, 1882, 399.  
Valve, Circular Slide-, 1877, 201.
- WALKER, B. P., Fire-Feeder, Mechanical, *Paper* on the Frisbie Mechanical  
Fire-Feeder and Grate for boilers and furnaces, 1876, 318.—Remarks,  
321, 324.  
Puddling, Mechanical, 1876, 274.
- WALKER, C. C., Boiler, Lancashire, 1876, 112.  
Power Transmission by Ropes, 1874, 70.  
Rules, 1874, 31.  
Secretary, Vote to late, 1878, 111, 112.
- WALKER, D., elected Member, 1877, 165.
- WALKER, G., elected Member, 1875, 315.
- WALKER, J., elected Member, 1877, 72.
- WALKER, J. S., elected Member, 1875, 315.
- WALKER, M., elected Graduate, 1884, 2.
- WALKER, R. T., elected Graduate, 1884, 199.
- WALKER, S. F., elected Member, 1884, 80.  
Boiler Corrosion, Marine, 1884, 340.  
Railway Electric Signals, 1884, 460.

- WALKER, T. F., elected Member, 1876, 347.
- WALKER, WILLIAM (Saltburn-by-the-Sea), elected Member, 1875, 36.
- WALKER, WILLIAM (London), elected Member, 1878, 108.
- WALKER, Z., JUN., elected Member, 1878, 31.
- WALKINSHAW, F., elected Graduate, 1881, 409.
- WALLACE, J., elected Member, 1884, 199.
- WALLAU, F. P., elected Member, 1884, 80.
- WALLSEND SLIPWAY AND ENGINEERING WORKS, Newcastle-on-Tyne, 1881, 585, 611.—Cardiff, 1884, 361.
- WALTON, J., Screw Propellers, 1879, 607.
- WARBURTON, J. S., elected Member, 1881, 10.
- WARD, T. H., elected Member, 1882, 146.
- WARD, W. M., elected Member, 1876, 347.
- WARDELL, S. C., elected Member, 1877, 166.
- WARDLE, E., elected Member, 1882, 16.
- WARHAM, R. L., elected Member, 1881, 409.
- WARNER, E., elected Member, 1874, 256.
- WARSOP, H., elected Member, 1882, 146.
- WASALEKAR, N. N., elected Associate, 1875, 315.
- WASS, J. W., elected Member, 1874, 101.
- WATCH FACTORY, visited at Autumn meeting, Birmingham, 1883, 597, 598.
- WATER EJECTOR, 1874, 292.—1877, 319, 336.
- WATER METER, *Paper* on Barton and West's piston Water Meter, by W. H. Thomas, 1879, 444.—Meter cylinder and case, 444.—Valves, 445.—Registering apparatus, 446.—Action of meter, 447.—Experiments to test meter, 447.—Tables of results, 448-450.
- Discussion.*—Parsons, Hon. R. C., Speed of meter, and head to work it, 450.—Welsh, E. J. C., Accuracy of meter depends on speed of valves, 450.—Paget, A., Proportion of size of piston to size of pipe, 451; action of spring valves, 451; importance of use of water meters, 451.—Head, Jeremiah, Defects of existing meters, and means of tampering with registration, 452; meters for boiler-feed should pass hot water, 453.—Hughes, G. D., Objection of possible leakage through meter without registration, 453.—Robinson, J., That depends on rapidity of action of valves, 454.—Barton, C. C., Action of valves nearly instantaneous, 454; piston speed, and corresponding head required, 454; liability of meters sticking, 454; sealing of register chamber, 455.—Robinson, J., Water meters not good for water companies, but for consumer, 455; any variation in Barton meter is constant, 455.
- WATER METERS, *Paper* on Meters for registering Small Flows of Water, by J. J. Tylor, 1882, 41.—Parkinson's drum meter, 41.—Kennedy's piston meter, 42.—Frost's piston meter, 42.—Siemens' turbine meter, 43.—Siemens'

## WATER METERS (continued).

fan meter, 44.—Tylor's fan meter, 45.—Measurement of small flows, 47.—District meters, 48.—Results of inspection by aid of meters, 49.—House meters, 50.—Tables I-XIII, tests and experiments with various meters, 52.

*Discussion.*—Tylor, J. J., Specimens of meters, and explanation of district meter diagrams, 64; diagram from Bridgwater waterworks, 64; ditto from London waterworks, 65; ditto illustrating method for inspecting, 66.—Anderson, W., Experiments with various meters at Erith Iron Works, 66; table of results, 68; description of Galasse piston meter, 67; registration by Galasse and Kennedy meters, 69; variations of turbine meters at low velocities, 69; practically no inaccuracy from inertia of turbine meters, 70; piston meters best for small services, rotary meters for large, 70.—Hawksley, T., Principle of turbine meter, 70; inaccuracy arising from friction, 71; case of fraudulent manipulation, 71; value of turbine meters for large supplies, 72; increase of capital if water supplied by meter, 72; Parkinson meter most perfect, but not always applicable, 73; Kennedy meter defective through liability to stick, 73; water supply by meter would be detrimental to health, 74; meters not necessary for suppression of waste, 74; examples of waste prevention by change to constant supply, 74.—Newman, F., Results from adoption of meters in South America, 75.—Rich, W. E., Inferential meters giving place to piston meters in Brussels and Paris, 76; clockwork registering meters should be movable, 77.—Paget, A., Former objections against gas meters now repeated against water meters, 77; diminished expense of fittings under supply by meter, 78.—Hawksley, T., Increased outlay for domestic supply by meter is independent of cost of consumer's fittings, 79.—Chaney, H. J., Average percentage of error in good meters, 79; want of sufficiently accurate meter, 80.—Williams, R. Price, Amount and cost of water wasted in London, 80; table of cost of water supplied, 81.—Cowper, E. A., How would capital outlay be increased or lessened by meter supply, 82.—Hawksley, T., Average cost of water, and how made up, 82; smaller supply by meter would necessitate higher rates of charge, 83.—Shoolbred, J. N., Principle of Deacon waste-water meter, 83; description of meter, 84; application, and results, 85.—Marten, E. B., Effect of substituting payment by meter instead of rating, 86; prevention of waste, and change from intermittent to constant supply, 87; application of Tylor meter, 88.—Schönheyder, W., Serious inaccuracy of best rotary meters, 88; use of piston meters on Continent, 89.—Hawksley, C., Accuracy of Parkinson meter, 89; relative cost of gas and water meters, 90; cheapness of water supply, 90; importance of good fittings on water services, 91; extent and cost of Bridgwater waterworks, 91.—Paget, A., Saving in cost of fittings by use

## WATER METERS (continued).

of meter, 91; insignificant value of unregistered supply through rotary meters, 92.—Tylor, J. J., Adoption of rotary meters in Germany and France, 92; advantage of dispensing with cisterns, 93; rare to supply houses by meter in England, 94; expense of meters, 94; advantage of meters for inspection of waste, 94; minimum charge for domestic supply by meter, 95; comparison of gas and water meters, 95.

*Appendix to Discussion.*—Cogger, J., Supply by meter at Newport, Isle of Wight, 96.—Palmer, J. E., Ditto at Great Malvern, 96.—Cole, G., Ditto at Hereford, 97.—Armitt, H., Ditto at Northampton, 98.—Walker, A. T., Ditto at Reading, 98.

WATER-POWER ENGINES, *Paper* on Water-Power Engines with variable stroke, by J. Hastie, 1879, 484.—Principle of engine, 484.—Modes of obtaining variation in stroke, 484.—Number of engines now at work on the principle, 485.—Description of engines for low-pressure, 485.—Automatic variation of length of stroke, 486.—Experiments on small hoist, 487.—Engine its own governor, 487.—Description of engines for high pressure, 488.

*Discussion.*—Alley, S., Excellent working of engine with various loads, 488.—Kennedy, A. B. W., Davey's plan of exhaust water-box, 489.—Tweddell, R. H., Efficiency of engine increases as stroke is lengthened, 489.—Paget, A., Plan of transmitting engine power through gear capable of variation by governor, 489.—Ellington, E. B., Use of reversing brake-valve, 490; how long has engine been at work, 490.—Welch, E. J. C., Economy in transmission of power by water instead of by shafting, 491.—Hastie, J., End of cylinder does work of slide-valve, 491; increase of efficiency with longer stroke, 491; successful use of reversing valve in geared engine, 492; simplicity of engine, 492; extent of application, 492.—Robinson, J., Great advantage in engine being its own governor, 493.

WATER-PRESSURE, *Paper* on the maintenance of Constant Pressure in water service pipes, by S. Alley, 1879, 423.—Waste by leakage under variable pressure, 423.—Detection of waste in Liverpool, 423; in Glasgow, 424.—Imperfect regulation of pressure by sluice valves, 424.—Importance of economising water supply, 425.—Foulis' water pressure regulators, 427.—Regulating valve or water-governor, 427.—Regulation by cistern and differential governor, 429.—Differential valve for proportionate pressures, 430.—Retentive valve for descending mains, 431.—Applications of the system, 432.

*Paper* on Barton and West's Water-Pressure Reducer, by W. H. Thomas, 1879, 434.—Description of reducer for mains, 434.—Ditto, ditto, for service pipes, 436.

## WATER-PRESSURE (continued).

*Discussion.*—Gray, J. M., Provision against failure of india-rubber diaphragms, 437; absolute tightness not necessary, 437. — Mair, J. G., Friction of leathers objectionable, 437; regulating valve should open downwards, 438. — Cochrane, C., Action of retentive valve, 438. — Macfarlane, W., Desirability of having several distributing reservoirs at various levels, 438. — Paget, A., Difficulties of such a system, 439; reducing valves almost identical in effect, 439. — Crompton, R. E. B., Trouble with water fittings by deposit from water, 439. — Cowper, E. A., Deposit of less importance with large valves, 440; india-rubber diaphragms in small valves would avoid piston friction, 440; specially adapted for Glasgow, 440. — Alley, S., Action of retentive valve, 441; friction of packing leathers, 441; period of working of regulating valves, 441. — Foulis, W., Principle peculiar to these regulating valves, 442. — Copland, W. R., Experiments to determine saving effected by Foulis' valve, 442. — Barton, C. C., Efficiency of Barton and West's pressure reducer, 443. — Robinson, J., Importance of preventing leakage in fittings, 443.

WATER-PRESSURE MINING ENGINES, *Paper on Water-Pressure Engines for mining purposes*, by H. Davey, 1880, 245. — Water supply in hilly districts, 245. — Principles of water-pressure engines, 246. — Trevithick's early water-pressure pumping engine, 247. — Double-acting dip-pumping engines at Griff colliery, 248. — Fluctuation of velocity in driving column, 250. — Plunger engines pumping brine at Mansfield salt-mine, 251. — Pumping and winding engines at A. D. lead mine, 252. — Pumping engine at Hutton Henry colliery, utilising feeder in shaft, 254. — Pumping engine with single pipe for supply and delivery, 255. — Modes of applying variable hydraulic power to varying resistances, 256.

*Discussion.*—Hawksley, C., Hydraulic machinery will work although drowned, 257. — Tweddell, R. H., Successful use of rotative water-pressure engines, 258; high efficiency of three-cylinder hydraulic engine, 258; accumulator not required, if acting merely as a regulator, 259; balanced valves, 259; variable hydraulic power, unless automatic, is not valuable, 259; future of hydraulic engines is a matter of working cost, 260. — Kennedy, A. B. W., Engine with several valves is preferable in certain cases to single-valve engine with numerous parts, 260. — Tweddell, R. H., Three-cylinder engine should only drive ordinary pump, 261. — Kennedy, A. B. W., Arrangement in paper preferable for heavy pumping, 261. — Crompton, T. R., Whether air-vessels not necessary on water-pressure engines, 261. — Davey, H., Air-vessels not necessary, 261; fluctuation of velocity small in driving column, 261. — Crompton, T. R., Air-vessel preferable under great head, 262. — Davey, H., Objection to air-vessels in awkward places, 262. — Crompton, T. R., Easy to replenish air-vessel, 262.



# WATER-PRESSURE MINING ENGINES (continued).

—Lightfoot, T. B., Steam more economical than water power for draining dip-workings, 262.—Davey, H., Reasons for adopting mitre valves in place of piston-valves or slide-valves, 263; rotative hydraulic engines not best suited for pumping, 263; reasons for preferring hydraulic power to steam in dip-workings, 264; working of dip engine at Griff colliery, 264.—Cowper, E. A., Paper gives practical record of successful working, 264.

WATER PRESSURE for driving machinery. *See* Hydraulic Machinery. Water-Power Engines. Water-Pressure Engines.

WATER PRESSURE for transmitting power. *See* Power Transmission.

WATER SUPPLY FROM CHALK, *Paper* on the Yield of Wells sunk in the Chalk in the central portion of the London basin, by E. Easton, 1876, 163.—Basin form of the chalk, 163.—Obstruction to passage of water from deflection of chalk and great fault in strata, 164.—Sudden alteration caused in water level in the chalk, 165.—Flow of water different in pure chalk districts, 165.—Only small portion of rainfall finds its way into chalk under London, 166.—Rate of inclination of water in chalk at Brighton, 167.—Uncertainty of finding water in any quantity in London basin, 167.—Analysis shows considerable admixture of water from the tertiary sands covering the chalk, 168.—Water level steadily lowering in wells as number increases, 168.—No great quantity of water can be expected under London, 169.

*Discussion.*—Easton, E., Peculiarity in variation of water level in wells at Brighton, 169.—Cowper, E. A., Decrease in general level of water in deep wells throughout London, 170.—Webb, F. W., Analysis of very soft water from well at Camden Town, 170.—Clay, W., Water from wells in sandstone at Liverpool found to be very salt, 170.—Amos, C. E., Plan for preventing difficulty arising from priming in locomotives, 171.—Webb, F. W., Salt in water of wells near sea, 172.—Hawksley, C., Causes of variation of water level at Brighton, 172.—Spon, E., Faults in chalk of London basin, 172; variable yields of wells in district, 173; level of water in wells, 173; flow of water through fissures in chalk, 173.—Easton, E., Gradual depression of water level in London wells, 174; no risk of getting salt water into Brighton wells if not sunk too deep, 174; highest level of water generally three or four months after greatest rainfall, 174; yield of water from London wells, 175; normal water level difficult to ascertain, 176.

WATER SUPPLY, Metropolitan, lengths of pipes and pressures of water, 1879, 377.

WATER WORKS, filtration, 1881, 151, 152, 155–161. *See* Filter.

WATER WORKS, MANCHESTER CORPORATION, Longdendale, 1875, 310.

WATKIN, W. J. L., decease, 1878, 22.—Memoir, 16.

Engines, Winding, Direct-Acting, 1875, 241, 242.

WATKINS, A., elected Member, 1881, 164.

WATSON, H. B., elected Member, 1882, 255.

WATSON, J., elected Associate, 1878, 31.

WATSON, R., decease, 1883, 36.—Memoir, 29.

WATSON, W. R., elected Member, 1879, 398.

WATSON'S HYDRAULIC PACKING PRESS for Cotton, 1877, 355.—1878, 52, 56.

WATT, *Paper on the Inventions of James Watt, and his Models preserved at* Handsworth and South Kensington, by E. A. Cowper, 1883, 599.—Photographs of models &c. have been obtained, 599.—List of illustrations, 600.—First patent 1769, 601.—Previous Newcomen pumping engines, 602.—Surface condenser, and injection, 603.—Air-pump, 603.—Separate surface condenser, 603.—High-pressure engine without vacuum, 604.—Piston packing and lubrication, 605.—Block-tin cylinder, 605.—Cylinders spring out of round in boring horizontally, 605.—Open-topped cylinder of single-acting pumping engine, 606.—Closing of cylinder top, and equilibrium valve, 606.—Substitutes for crank motion, 607.—Model of single-acting rotary engine with heavy balance-weight, 607.—Sun-and-planet motions, 607.—Crown-cam motion, 608.—Ladder motion, 608.—Double-acting engine 1782, 609.—Parallel motion, 609.—Model of double-acting arrangement, 610.—Expansion of steam, 611.—Steam indicator, 611.—Modes of equalising motion with expansion, 612.—Compound engine, 613.—Bull engine, 613.—Rotary motions in opposite directions, 613.—Steam carriage for common roads, 614.—Boilers made of wood, 614.—Limitation of steam pressure, 614.—Cugnot's road locomotive, 614.—Forge and tilt hammers, 615.—Wagon boiler and setting, 615.—Rotary and semi-rotary engines, 616.—Watt's room in Heathfield Hall, 616.—Counter, 617.—Folding wedges, 617.—Letter-copying presses, and copying-ink powders, 618.—Sculpture-copying machine, 618.—Pyramidal stiffened frame, 619.—Drills and cutters, 619.—Reducing machine, 620.—General effects produced by Watt's inventions, 621.

*Discussion.*—Cowper, E. A., Supposed model of hot cylinder with cold separate condenser, 622; engraving of Newcomen engine, 623; Watt's rotative and double-acting engine, 624; low-pressure or vacuum engines, 624; introduction of higher pressures, 624; old hay-stack and wagon boilers, 624.—Timmins, S., Preservation of relics of Watt, 625.—Marshall, W. P., Ditto. 626.—Head, J., Visit to Watt's room, 626; wagon boilers on Tyneside, 627.—Davey, H., Murdock's assistance in making lathe-frame rigid, 628.—Marten, E. B., Model lent by Mr. Skidmore, 628.—Hall, W. S., Double-acting rotative engine by Watt, at work lately, 629; Watt's spectacles, 629; boiler-pressure below atmosphere, 630.—Timmins, S., Early timber-beam engine still working in Birmingham, 630.—Westmacott, P. G. B., Interest of subject to engineers, 630.

- WATT AND CO.'S ENGINE WORKS, Soho, Birmingham, 1876, 329.
- WATTS, J., elected Member, 1877, 299.
- WAUGH, J., elected Member, 1877, 72.
- WEARMOUTH COLLIERY, visited at Newcastle meeting, 1881, 615, 616.
- WEATHERHEAD, P. L., elected Member, 1878, 31.
- WEBB, F. W., elected Member of Council, 1875, 34.—Vice-President, 1877, 25.—  
1878, 29.—1881, 30.—1884, 21.
- Axlebox, Radial, 1877, 306, 308, 312.
- Boiler Feeder, Fromentin Automatic, 1882, 489.
- Gauge, Railway, 1875, 82.
- Hydraulic Machinery, Marine, 1874, 47, 53.
- Injector Hydrants, 1879, 384, 393.
- Iron and Steel for Boilers, 1879, 304.
- Locomotives, Compound, 1879, 349, 353. — *Paper* on Compound  
Locomotive Engines, 1883, 438.—Remarks, 452, 460.
- Locomotives, Francq's Fireless, for Tramways, 1879, 630.
- Locomotives, Fuel Consumption, 1884, 119.
- Plate Rolling Machinery, 1880, 94.
- Puddling, Mechanical, 1876, 260.
- Railway Traffic, Cost of, 1878, 207, 208, 213.
- Raising of wreck "Edith," 1878, 134.
- Riveted Joints, 1881, 260.
- Safety Lamps, 1879, 236.
- Saw, Direct-Acting Circular, *Paper* on a Direct-Acting Circular Saw for  
cutting steel hot, 1875, 126.—Remarks, 129, 130, 132.
- Steel, Fluid-Compressed, and Guns, 1875, 293, 296, 303.
- Tuyere, Open Spray, 1876, 365, 370.
- Valve, Circular Slide-, *Paper* on an improved form of Slide-Valve for  
steam and hydraulic engines, 1877, 197.—Remarks, 200, 203, 205.
- Valve-Gear, Joy's, 1880, 432, 435, 440.—Letter on, 1881, 417.
- Valves, Safety, 1877, 182, 187.
- Water Supply from Chalk, 1876, 170, 171.
- WEBB'S COMPOUND LOCOMOTIVE. *See* Locomotives, Compound. *See* Locomotives  
Fuel Consumption.
- WEBB, R. G., elected Member, 1884, 80.
- WEBSTER, J., elected Member, 1875, 189.—Decease, 1876, 3.—Memoir, 25.
- WECK, F., elected Member, 1883, 310.
- WEEMS, W., High-Pressure Vessels, 1878, 276, 283.
- WEIR, movable weir across the Marne at Noisiel, 1878, 550.
- WEISS, H. A. O., elected Member, 1879, 38.
- WELCH, E. J. C., Boiler and Engine, High-Pressure, 1877, 143.  
Boiler, Lancashire, 1876, 109, 112.

## WELCH, E. J. C. (continued).

Brakes, Continuous, for railway trains, 1878, 84, 99.

Drilling Machines for Boiler Work, 1878, 579.

Institution, Constitution of, 1878, 42.

Locomotives, Franco's Fireless, for Tramways, 1879, 634

Power Transmission by Ropes, 1874, 70.

Presses, Hydraulic Packing, 1877, 367.

Rock-Drilling Machinery, 1874, 96.

Rope Gearing, 1876, 382, 389.

Rules, 1877, 43.—1879, 587.

Steam-ship "City of Rome," 1880, 555.

Ventilators for Mines, Mechanical, 1875, 327.

Ventilator, Roots' Mine, 1877, 110.

Water Meter, Barton and West's, 1879, 450.

Water-Power Engines, 1879, 491.

WELCH'S SCREW ADJUSTMENT for pitch of drill spindles, 1878, 567, 579.

WELLS, Yield of, in Chalk in London Basin. *See* Water Supply from Chalk, 1876, 163.

WENDELSTEIN, E., Railway, St. Gothard, *Paper* on the Construction and Working of the St. Gothard Railway, 1883, 463.

Tunnel, St. Gothard, *Paper* on the St. Gothard Tunnel, 1883, 156.—Remarks, 176, 177.

WEST, C. D., elected Member, 1882, 255.

WEST, H. H., elected Member, 1876, 57.

Raising of wreck "Edith," 1878, 129.

Steel Boiler Experiments, 1878, 247.

WEST, J., Centrifugal Separator, 1882, 523.

WEST, N. J., elected Member, 1874, 101.

WEST'S HYDRAULIC PRESS for pressing cotton, 1878, 59.

WESTERN, C. R., elected Member, 1877, 166.

WESTERN, M. R., elected Member, 1877, 26.

WESTINGHOUSE, G., JUN., Brakes, Automatic Action, 1880, 137.

Brakes, Continuous, for railway trains, 1878, 93, 98.

Brakes, Effect of, upon railway trains, 1878, 480.—1879, 213.

WESTINGHOUSE COMPRESSED-AIR BRAKE for railway trains, 1878, 76, 79, 87, 93, 592, 607, 622, 624.

WESTMACOTT, H. A., elected Graduate, 1883, 310.

WESTMACOTT, P. G. B., elected Member of Council, 1874, 26.—Vice-President, 1876, 26.—1877, 25.—1878, 29.—1880, 24.—Nominated as President, 1881, 411, 625.—Elected President, 1882, 32.—1883, 53.

Addresses, Presidential, at Leeds meeting, 1882, 259.—At Belgian meeting, 1883, 317.

WESTMACOTT, P. G. B. (continued).

Belgian meeting, Reply to Mayor's welcome at Liège, 1883, 307; ditto at Antwerp, 314.—Invitation from H. M. the King of the Belgians, 311.—*Address*, 317.

Blast-Furnace Working, 1882, 317.

Boiler Feeder, Fromentin Automatic, 1882, 488, 489, 496.

Brake, Automatic Screw-Brake, 1882, 508.

Coke Manufacture, 1883, 305.

Council, Annual Report, 1884, 19, 20.

Cutting of Metals, 1883, 263, 266.

Diving Appliances, 1882, 198.

Docks, Cardiff, 1874, 133.

Dredger, Bazin, 1882, 115.

Expansion-Gear, Automatic, 1882, 438.

Friction Experiments, 1883, 659.

Friction at High Velocities, 1882, 150.

Harbour Works, Antwerp, 1883, 315, 316.

Hydraulic Machinery, Workshop, 1874, 179.

Institution business, 1883, 34.

Leeds meeting, Reply to Mayor's welcome, 1882, 252.—Tribute to memory of W. Menelaus and C. P. Stewart, 253.—*Address*, 259.

Lifts, Hydraulic, 1882, 175.

Power Transmission by Ropes, 1874, 71.

President, on election as, 1882, 34.—On retiring from office, 1884, 23.

Railway, St. Gothard, 1883, 492.

Rock-Drilling Machinery, 1874, 95.

Rules, 1883, 596.

Shafting, Strength of, 1883, 225.

Sowing of Seed, Machinery for, 1882, 250.

Steel, Hardening &c., 1883, 71.

Steel, Tempered, Molecular Rigidity of, 1883, 92.

Sugar Manufacture in Belgium, 1883, 312.

Testing Machine, Single-Lever, 1882, 391, 403, 407.

Valve, Circular Slide-, 1877, 202, 203.

Watt, Inventions of James Watt, 1883, 630.

Wool-Combing Machinery, 1882, 227, 230.

WESTMACOTT'S COALING CRADLE, 1884, 229.

WESTMORELAND, J. W. H., elected Member, 1880, 489.

WESTPHALIA, Shaft-Sinking, 1882, 335. *See* Mining Machinery.

WESTWOOD, J., JUN., elected Member, 1880, 9.

WEYMOUTH, F. M., elected Graduate, 1880, 186.

WHALLEY, A. J., elected Member, 1874, 27.—Decease, 1877, 3.—Memoir, 23.



- WHARTON, H. E., elected Member, 1883, 310.  
 WHARTON, W. A., elected Member, 1881, 624.  
 WHEATLEY, T., decease, 1884, 3.—Memoir, 74.  
 WHIELDON, J. H., elected Member, 1884, 199.  
 WHITE, A. E., elected Member, 1882, 255.  
 WHITE, H. W., elected Member, 1874, 55.  
 WHITELEY, W., elected Member, 1876, 197.  
 WHITELOCK, W. T. G., elected Graduate, 1877, 300.  
 WHITHARD, B. M., elected Member, 1884, 2.  
 WHITLEY, J., Forging of Crank Shafts, 1879, 473.  
 WHITWELL, T., decease, 1879, 22.—Memoir, 18.  
 WHITWORTH, SIR J., Puddling, Mechanical, 1876, 279.  
     Steel and Guns, *Paper* on Fluid-Compressed Steel and Guns, 1875, 268.—  
     Remarks, 281, 290, 295, 303.  
 WHITWORTH, SIR JOSEPH, AND CO.'S WORKS, 1875, 305.  
 WHITWORTH'S FLUID-COMPRESSED STEEL, 1875, 268. — 1880, 171, 179, 180,  
 181.  
 WHYTEHEAD, H. E., elected Graduate, 1878, 31.  
 WICKHAM, L. W., decease, 1884, 3.—Memoir, 75.  
 WICKS, H., elected Member, 1878, 293.  
 WICKSTEED, J. H., Cutting of Metals, 1883, 253.  
     Drilling Machines for Boiler Work, 1878, 578.  
     Dynamometer, Marine-Engine, 1877, 265.  
     Friction Experiments, 1883, 653.  
     Steel Boiler Experiments, 1878, 244.  
     Testing Machine, *Paper* on a Single-Lever Testing Machine, 1882, 334.—  
     Remarks, 402, 403.  
 WIDMARK, H. W., elected Member, 1878, 108.  
     Axlebox, Radial, *Paper* on improved Radial Axleboxes and Guides, 1877,  
     304.—Remarks, 306, 309, 313.  
 WIGZELL, E. E., elected Member, 1881, 164.  
 WILDER, J., elected Member, 1884, 2.  
 WILKIESON, Major-General C. V., R. E., decease, 1879, 22.—Memoir, 19.  
 WILKINSON, R., elected Member, 1877, 26.—Decease, 1884, 3.  
 WILKINSON, W., elected Member, 1884, 409.  
 WILLIAMS, D., elected Member, 1874, 101.  
 WILLIAMS, E., Address of President, 1880, 320.  
     Blast-Furnace Working, 1882, 312.  
     Forging of Crank Shafts, 1879, 471.  
 WILLIAMS, E. L., elected Member, 1883, 310.  
 WILLIAMS, Sir F. M., decease, 1879, 22.—Memoir, 19.  
 WILLIAMS, J. B., elected Member, 1884, 2.

- WILLIAMS, J. R., elected Member, 1884, 199.
- WILLIAMS, R. P. *See* Price-Williams, R.
- WILLIAMS, W. F. M., elected Member, 1881, 10.
- WILLIAMSON, R., elected Member, 1883, 310.
- WILLIAMSON, R. S., elected Associate, 1883, 310.
- WILLIAMSON SAFETY LAMP, 1879, 223. *See* Safety Lamps.
- WILLIS, R. H., Riveted Joints, 1881, 282.
- WILLMOTT, A. W. W., elected Member, 1883, 180.—Honorary Local Secretary for Antwerp, Summer meeting, 1883, 313.
- WILLOCK, Lieut. H. B., elected Member, 1884, 80.
- WILSON, ALEXANDER (Dronfield), elected Member, 1878, 558.
- WILSON, ALEXANDER (London), elected Member, 1884, 199.
- WILSON, A. B., elected Member, 1882, 255.
- WILSON, E., decease, 1878, 22.—Memoir, 17.
- WILSON, G. P., elected Member, 1883, 593.
- WILSON, JAMES, elected Member, 1884, 80.
- WILSON, JOHN, elected Member, 1881, 624.
- WILSON, J. C., elected Member of Council, 1878, 29.  
     Hydraulic Machinery, Toulon, 1878, 389.  
     Valve, Circular Slide-, 1877, 201.  
     Valves, Safety, *Paper* on the construction of Safety Valves, 1877, 176.—  
     Remarks, 182, 194.
- WILSON, J. W., elected Member, 1879, 38.
- WILSON, ROBERT (Patricroft), decease, 1883, 36.—Memoir, 29.  
     Governors, 1879, 415.  
     Presses, Hydraulic Packing, *Paper* on an improved construction of  
     Hydraulic Presses for packing cotton, jute, &c., with improved engines  
     and pumps, 1877, 349.—Remarks, 354, 362, 363, 374.
- WILSON, ROBERT (London), elected Member, 1880, 9.
- WILSON, ROBERT (Patricroft), elected Member, 1883, 310.
- WILSON, T., elected Member, 1884, 80.
- WILSON, W. W., elected Member, 1881, 10.
- WILSON'S HYDRAULIC PRESS for pressing cotton, 1878, 52.
- WINBY, F. C., Locomotive, Brown's Tramway, 1880, 63.  
     Tramways, Permanent Way, 1880, 215, 220.
- WINNY'S Permanent Way for Tramways, 1880, 198, 215, 220. *See* Tramways,  
     Permanent Way.
- WINDERMERE LAKE, visited at Barrow meeting, 1880, 480, 488.
- WINDING ENGINES, DIRECT-ACTING, 1875, 217. *See* Engines, Winding, Direct-  
     Acting.
- WIRE ROPES, Power Transmission by. *See* Power Transmission, 1874, 56.—  
     1881, 57.

- Wise, W. L., Council, Annual Report, 1884, 20.  
 Patent Laws, 1875, 176, 184.  
 Rules, 1874, 30.—1876, 30.
- Withy, E., Ships, Iron and Steel for, 1881, 566.
- Withy, H., elected Member, 1884, 199.
- Wolfe, J. E., elected Member, 1878, 108.
- Wolfenden, Richard, elected Member, 1878, 31.
- Wolfenden, Robert, elected Member, 1878, 31.
- Wolff, J. F., elected Member, 1882, 225.
- Wood, E. M., elected Member, 1881, 409.
- Wood, E. W. N., elected Graduate, 1879, 156.
- Wood, J. M., elected Graduate, 1880, 10.
- Wood, S. P., elected Member, 1884, 80.
- Wood, T., elected Member, 1876, 347.
- Wood's wrought-iron cross sleepers for railways, 1880, 214.
- Woodall, C., elected Member, 1882, 146.
- Woodhead, J. P., memoir, 1884, 404.
- Woods, H., Bath, Floating Swimming, 1875, 150, 152.  
 Saw, Direct-Acting Circular, 1875, 130.
- WOODSIDE IRON WORKS, 1876, 337.
- WOODWARD, W., elected Member, 1884, 409.
- WOOD-WORKING MACHINERY, *Paper* on Wood-Working Machinery, by T. N. Robinson, 1875, 248.—Cutting tools for wood-working, 248.—Saws, forms of teeth, 249.—Action of cutters, 250.—Cutters and cutter-blocks for various woods, 251.—Cutter and cutter-block for tenoning, 251.—Boring tools, 252.—Speed of cutting tools, 252.—General construction of wood-working machines, 253.—Horizontal single-bladed saw-frame for fine sawing from rough logs, 253.—Planing and moulding machine for finishing timber, 255.—Fixed knives used for cutting smooth surface, 256.—Conical bearing with end set-pin for keeping spindle of cutter-block perfectly steady and lubricated at high speed, 257.
- Discussion.*—Robinson, T. N., Cutting angles of tools, 258; conical end-bearing for cutter spindle, 258.—Anderson, J., LL.D., Wood-working machinery still in its infancy, 258; better means required of fixing and balancing cutters, 259; spiral cutters of thin steel in French machines, 259; sharpening cutters in their place by revolving emery wheels, 259; scraping instrument for finishing off work, 260.—Shepherd, J., Helical cutter originally used for cloth-cutting machines, 261.—Barrow, J., Arrangement for sharpening teeth of band-saw successfully used for cutting iron, 261; setting teeth by right-and-left-handed cutters, 262; speed of driving, 262.—Anderson, J., Band knives for cutting out cloth 262.—Reynolds, E., Large sizes of band-saws, 263.—Cowper, E. A.,

## WOOD-WORKING MACHINERY (continued).

Circular saw used for cutting iron bars at an angle, 263; American saw with loose teeth, 263; extra planing iron for finishing off wood smooth, 263; wood sash-bars for 1851 exhibition building made entirely by machinery, 263.—Head, J., Speed of circular saw limited only by unsteadiness caused by saw not being perfectly true, 264; conical bearing with end set-pin, advantage, 265.—Robinson, T. N., Working of horizontal saw, 265.—Bramwell, F. J., Comparative advantages of single-bladed horizontal saw and multiple saw-frame, 265.—Robinson, T. N., Multiple saw not suitable for cutting veneers, 266; helical cutter for squaring up timber, 266; objections to emery wheels for sharpening cutters while at work, 266; practical limit of speed for circular saw, 267.

WOOL-COMBING, *Paper* on Wool-Combing by modern machinery, by F. M. T. Lange, 1882, 214.—Combing wool by hand, 214.—First wool-combing machine, Cartwright's, 215.—Godart's or Collier's machine, 216.—Chief subsequent combing machines, 217.—Heilmann's 218.—Lister and Donnisthorpe's, 218.—Preller and Eastwood's, or Opell's, 218.—Crabtree's, 218.—Noble's, 219.—Rawson's, 219.—Holden's, 220.—Smith and Bradley's, and Mirfield & Scott's, 220.—Little and Eastwood's, 221.—Lange's, 221.—Description of successive operations in Lange's wool-combing machine, 221.—Advantages realised in working, 224.

*Discussion.*—Cowper, E. A., Operation of combing by hand, 224.—Lange, F. M. T., Samples of combed wool and noil from improved machine, 225; tabulated comparison of combing by old machine and by Lange machine, 226; percentage of noil to cardings, 226; production of "top" per day, 226; construction of combs, 226; strength and elasticity of wool fibre, 227; Westmacott, P. G. B., Size of large receiving comb, 227.—Lange, F. M. T., Diameter 3 feet, 227.—Greenwood, A., Manufacture of Lange machine, 227.—Lange, F. G., Progressive improvement of machine, 228; increased number of rows of teeth in combs, 228.—Cowper, E. A., Economy resulting from improvements in combs, 229; avoidance of strain on wool in combing, 229; quick adjustment for different classes of wool, 230.—Westmacott, P. G. B., Beautiful specimen of mechanism, 230.

WOOLLCOMBE, R., elected Graduate, 1882, 16.

WOOLLEN MANUFACTORIES, Verviers, 1883, 515, 546–552.

## WORKS VISITED:—

Cardiff Summer meeting, 1874, 162, 234.

Manchester Summer meeting, 1875, 246, 305.

Birmingham Summer meeting, 1876, 327.

Bristol Summer meeting, 1877, 296.

Paris Summer meeting, 1878, 546.

Glasgow Summer meeting, 1879, 567.

## WORKS VISITED (continued).

Barrow Summer meeting, 1880, 478.

Newcastle Summer meeting, 1881, 595.

Leeds Summer meeting, 1882, 451, 454, 466, 468.

Belgium Summer meeting, 1883, 511-585.

Cardiff Summer meeting, 1884, 357. — Lists, 360, 392. — Descriptions, 360-397.

Nottingham Autumn meeting, 1884, 414.

WORSDELL, T. W., elected Member, 1874, 101.

WORSSAM, C. S., elected Member, 1884, 409.

WORSSAM, H. J., elected Member, 1877, 72.

WORSSAM, S. W., elected Member, 1876, 28.

WRECK, Raising of, 1878, 116. *See* Raising of Wreck.

WRENCH, J. M., elected Member, 1881, 624.

WRIGHT, B. F., elected Member, 1881, 164.

WRIGHT, G. H., elected Member, 1878, 558.

WRIGHT, JAMES, elected Member, 1876, 57.

WRIGHT, JOSEPH (Tipton), Rules, 1876, 29.

WRIGHT, O., decease, 1884, 3.—Memoir, 75.

WRIGHT, P., decease, 1875, 3.—Memoir, 32.

WRIGHT, W. B., elected Member, 1878, 293.

Brakes, Continuous, for railway trains, 1878, 90, 92.

Locomotive Running Shed, 1884, 251.

WRIGHTSON, T., Compressed-Air Machinery, 1874, 225.

Hydraulic Machinery, Workshop, 1874, 194.

WYLLIE, R., elected Member, 1883, 593.

WYNNE-EDWARDS, T. A., elected Member, 1883, 180.

WYVILL, F. C., elected Member, 1877, 72.

## Y.

YATES, H., elected Member, 1878, 31.

YATES, H. R., elected Member, 1882, 16.

YATES, L. E. H., elected Member, 1881, 164.

YATES, W., elected Member, 1880, 489.

YEOMANS, D. M., elected Member, 1879, 38.

Brakes, Automatic Action, 1880, 136.

Brakes, Effect of, upon railway trains, 1878, 484, 624.—1879, 195.

YOKOI, S., elected Graduate, 1884, 409.

YORK, F. C., elected Graduate, 1880, 186.

YOUNG, C. F. T., Boiler and Engine, High-Pressure, 1877, 130.



YOUNG, G. S., elected Member, 1879, 155.

YOUNG, JAMES (Fence Houses), elected Member, 1874, 55.

YOUNG, JAMES (Low Moor), elected Member, 1879, 398.

YOUNGER, R., elected Member, 1881, 624.

YULE, W., decease, 1882, 17.—Memoir, 14.

## Z.

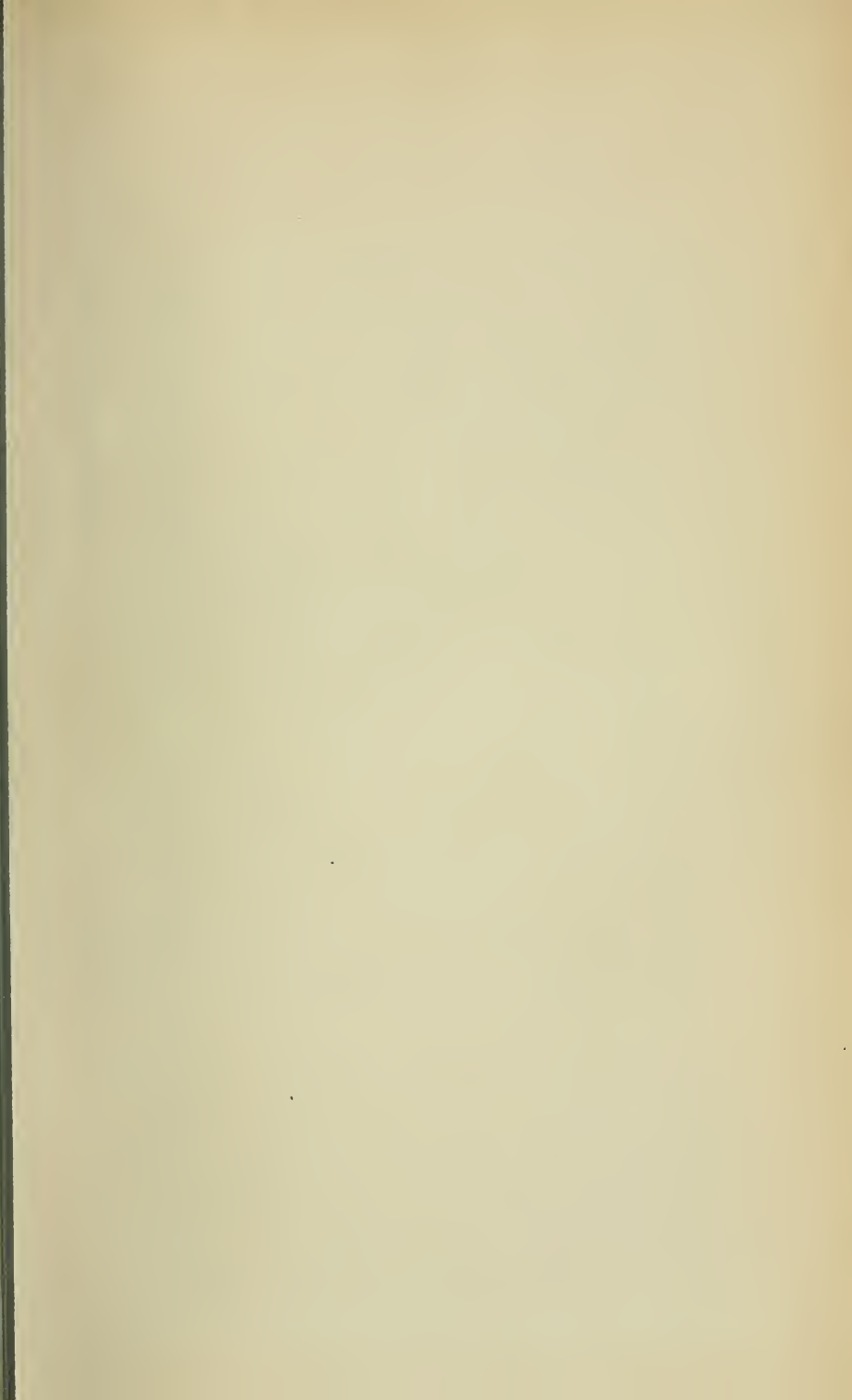
ZIFFER, F. H., elected Member, 1880, 9.

ZINC, *Paper on the Manufacture of Zinc in Belgium*, by St. Paul de Sinçay, 1883, 345.—Early workings of calamine, 345.—Extraction of zinc, 347.—Dony's reduction of zinc ores, 348.—Vieille-Montagne works, 349.—Other works, 349.—Total production of zinc in Belgium, 352.—Reduction of blende, 352.—Importation of foreign ores, 353.—Workmen, 354.—Metallurgy of zinc, 355.—Rolled zinc, 356.—Oxide of zinc, 359.—Direct use of ingot zinc, 360.—Make of raw zinc in Europe since 1860, 361.

*Discussion.*—Rocour, G., Commercial difficulties attending manufacture of zinc, 362; difficulty of smelting, 363; retorts made by hydraulic pressure, 363; use of gas furnaces, 363.—Roberts, W. C., Belgian method of manufacture in Swansea, 364; difficulty from fracture of retorts, 364.—Sharp, T. B., Shape of ingots of zinc should be round instead of flat, 364; recovery of oxide of zinc in manufacture of brass, 365.—Rocour, G., Fracture of retorts, and use of blast-furnace, 366.—Cochrane, C., Zinc works will be seen, 367.

ZINC WORKS, Vieille Montagne, 1883, 349.—Visited at Summer meeting, Belgium, 1883, 513.







TJ Institution of Mechanical  
1 Engineers, London  
I4 Proceedings

Index

1847-84

~~Physical &~~

~~Applied Sci~~

~~Serials~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

~~University of Toronto~~

~~Library~~

~~Engineering~~

~~Library~~

Engineering  
PLEASE DO NOT REMOVE  
CARDS OR SLIPS FROM THIS POCKET

---

UNIVERSITY OF TORONTO LIBRARY

---

ENGINE STORAGE



